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Published in collaboration with
Menaka Prakashan
(Publication division of MediaNext)
2117, Sadashiv Peth,
Vijayanagar Colony,
Pune – 411 030, Maharashtra

Email: sales@menakaprakashan.com
Webstore: www.menakabooks.com

For subscriptions: 9823 69 69 60

Printed at:
Vikram Printers, Parvati,
Pune – 411009

Single issue price ₹ 400	Annual Subscription ₹ 2000 (Includes postage)	Please turn to last page for subscription form. To subscribe online, please visit www.menakabooks.com

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CASS Journal
Volume 3, No. 3, July–September 2016

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Editor's Note

"Vision without Action is daydream,
Action without Vision is Nightmare."

–Unknown

Brexit, certainly a momentous event in this 'Global Village'! I hope those who voted to stay out of EU have the vision to tide over economic, political and social issues, which will impinge not only Britain but many other nations.

China is another country which needs to do some soul searching for a long term vision especially when it sides with Pakistan not just over NSG membership of India but also uses veto power at UN to shelter terrorists like Masood Azhar and Zaki-ur-Rehman Lakhvi.

I write this Editor's note from half way across the globe, in New York, while on some work cum holiday. But while keeping abreast with the events back home in India, the heart is filled with pride knowing of ISRO's creditable feat of launching 20 satellites with just one PSLV. Coming soon after the successful operationalising of GAGAN, our own regional navigation system, there are a number of writings in US media about India's positive strides in aerospace technology. It is also nice to read about India's membership into MTCR regime.

It is hoped that after two successive bad monsoons, this year the rains are expected to be normal. But like in all our earlier years let us not allow most of the rain water to flow into seas. Water storage, ground water charging and water

management to avoid wastage is a must and while a number of schemes have been announced by the Government, every citizen needs to pitch in to meet the challenge of water shortage.

With its increasing lethality and ability to strike with alacrity, former Chief of Air Staff has written an article on the future of Aerospace Power especially in the Indian context. The issue also carries two articles on GAGAN by experts who have been with ISRO. They have reflected on the advantages to India of such an independent and indigenous regional navigation system.

With Middle East facing turbulent times, low oil prices have made many of the oil rich nations to look beyond the assured income from 'black gold'. Saudi Arabia has therefore come up with a document Vision-2030, which has implications not only for the politico-economics of the region but also for India. An article elaborates on these issues. With India joining MTCR, an article on the armed Predator drone reflects the need for our country to acquire such system, especially in the battle against terrorism.

China is being belligerent in recent times not only with her neighbours but also by taking laws of the seas in her own hand, by creating artificial islands in South China Sea. This issue carries three analytical articles related to China; first on the increasing prowess and modernisation of Chinese Air Force, second on China-Pakistan Economic Corridor in tune with Chinese vision of 'one belt, one road', and lastly on the recent Chinese White Paper on Xinjiang, which places severe curbs on ethnic Muslim population.

The issue also carries an article on the important aspect of Tactical Nuclear Weapons, use of which Pakistan espouses for sabre rattling to avoid an open war with India but continues to wage the proxy war by supporting terrorism. The issue also has an article on International co-operation by the Indian Armed Forces, an important aspect of Military Diplomacy which had not been practiced by India till about two decades ago, to her own disadvantage.

I wish to thank all the authors, subscribers and readers for your whole hearted support.

Best wishes and happy reading.

(Bhushan Gokhale)
Air Marshal (Retd)
Director, CASS

Date: 27th June 2016

Future of Aerospace Power

Air Chief Mshl PV Naik (Retd)

1. Douhet, Mitchell & Trenchard were the first proponents of Air Power, as it was known then. They were ahead of their times & consequently, were hounded out by one & all for their heretical thoughts. Now, as you all know, Air Power is synonymous with Aerospace power. In fact both are interchangeable. This paper attempts to flag some important aspects of & share some thoughts on The Future of Aerospace Power, with special reference to India.

Environment

2. Today the South Asian Region ranks as one of the three flashpoints in the world along with the Middle East & North Korea. That the potential adversaries are Nuclear powers with missile capability is a cause for even greater discomfort. It is, on the other hand, also a region with enormous possibilities, some of them unfolding right before our eyes. Within this region lies a group of Nations in troubled transition to modernity, their external discourse damned by internal contradictions. In a world moving towards integration, many of these Nations remain torn by ethnic & religious strife, economic disparities & political instability. Undoubtedly, it is a new world order that is emerging because of complex relationships, strategic interests and influences. Asia is the happening place and for a variety of factors. For obvious reasons, it is full of turmoil and instabilities. Internal

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 09–18

dynamics and external influences have led to increase in the degree of instability and uncertainty. Last but not the least; it is the playground terrorism .

3. As a member of this region, India remains vulnerable to the disturbances spilling over from her neighbours. India herself is at a crossroads. We witness this giant stirring into wakefulness – into an awareness of its power today. This rise in stature brings with it greater responsibilities & a larger role in regional as well as global affairs. This demands not only a change in policy, internal & external, but a fundamental change in our very thinking, ethos & value system.

Threat Spectrum

4. India's strategic perspectives are shaped by her history, geography, geo-political realities & the demands of real-politik. Our native culture, our innate traditions of trust & tolerance, & our vision of world peace shape our national character, which, in turn, impacts on our international relations. These vital parameters are as relevant today as they have been earlier. India shares borders with 11 neighbours. Our relations with some are uneasy and with some, hostile. Any unrest within this somewhat hostile neighbourhood spills over into our borders in many forms; & with depressing regularity. Unless these geo-political cross currents affecting us are quietened, they would continue to thwart our desire to move forward.

5. India is faced with a full spectrum of threats, which emerge from all these issues. The spectrum itself is increasing in complexity and technological sophistication. So with the spectrum changing as well as being unpredictable, we have to look at full-spectrum dominance. This is equally applicable to all domains, land, sea air, space, as well as the Information domain. Since the focus of this article is on Aerospace Power, suffice it to say that Aerospace Power also will have to look in the same direction.

6. It is, therefore, prudent that we move away from a threat-based assessment to a capability-based approach. A capability can then be tailored or applied to meet the challenge. The capability will allow

us to apply the right force in any form of conflict across the entire spectrum. This will ensure effectiveness as well as efficacy.

7. What is of concern to us is that the whole focus is on full-spectrum dominance. Yes, it will require new technology, modernisation and replacement of equipment. But just material-superiority and technology is not enough. Of equal importance is the development of doctrine, organisation, training and education of leaders and people who can effectively take advantage of the technology.

Aerospace Power

8. If we analyse the wars/skirmishes in the recent past, two 'Gospel Truths' have emerged. The first is 'Aerospace Power by itself cannot win a war'. The contradiction is that 'No major war has been won without the use of Aerospace Power'. This is likely to hold true for the foreseeable future also. It does not decry or belittle other forms of military power like Land or Sea; but is slowly & surely emerging to be a 'given' that aerospace power is the power of the future.

9. The corollary, therefore, that Aerospace Industry is the industry of the future is equally true. Hence any country aspiring for greatness must concentrate on & invest in aerospace power & aerospace industry.

10. Let us have a brief look, then, at 'What is Aerospace Power?' There is popular belief that aerospace power is about ac & satellites. This is not altogether wrong, but a little qualification would make the statement more accurate. Aerospace Power is the' Total capacity of a nation to exploit the medium of air & space.' Besides ac & satellites it involves civil aviation, passenger & cargo; Comn systems for management & control; radars, data links; airfds,RANADS,support infrastructure. It involves a strong technological base capable of absorbing new hi tech; a pool of techno savvy & trained manpower; hi tech trg centres & labs. It involves a strong manufacturing sector- both Public & Pvt- with the will & enthusiasm to put the money where the mouth is; with sufficient depth & dexterity to adapt to hi tech; impeccable processes leading to high quality consciousness & control. Equally important is the user commitment which ensures

viability. It involves investment & commitment to R&D. It demands a clear, comprehensive policy & an org to nurture this activity. Last but not the least, it requires National Will.

11. Colloquially speaking, Aerospace power is synonymous with its military aspect. The military aspect of aerospace power ensures that a nation has the freedom to exploit & exert the full spectrum of its aerospace power. This, as is well known, includes ac, satellites, launch platforms, wpns, radars, comn, Air Defence, Space control, cyberspace mgt & many other aspects. In this paper this Military aspect is discussed further in three parts :-
    a. Capability Build up.
    b. Crystal Ball Gazing into the future of Aerospace Power, esp in India.
    c. What do we need to do.

Capability Buildup

12. Environment. First of all we need to analyse the geopolitical environment obtaining around us. We have already been through this earlier. The highlights are that we face the full spectrum of threats from nuclear to terrorism. So we need to go in for full spectrum dominance.

13. Policy Directives. The Raksha Mantri issues the RM's directive for war to all three Chiefs. This spells out details like threat assessment, type of war likely, single or multi front war, expected days of intense or less than intense conflict ; etc. But there is no policy on how to prepare for war or how to build up capability. For this each Service has to fall back on its own experience & brain power.

14. Mission. An important factor to consider is the Mission. The msnof the Air Force is' To protect the country from threats arising through the medium of air & space.' Similarly, Army will have it for 'Land' & Navy for 'Sea'.

15. Aspirations. The IAF should be able to meet the aspirations of the country. The PM has already defined our Zone of Influence to be

from the Gulf of Hormuz in the West to Malacca straits & beyond in the East.

16. Analysis. For a detailed analysis of all factors one follows the 'Appreciation' method where one considers all threats to the country, however small. A threat is anything that prevents the country from achieving her goals, objectives or from meeting the aspirations of her people. After our analysis we realized that if we went country specific it would result in a never ending arms race. So we decided to go capability specific. What capabilities would we require to meet the country's aspirations. Putting it simplistically, there would be four supporting pillars for the buildup.

SEE, REACH,HIT & PROTECT;-

a) See. We should be able to see first & farthest. This pillar of capability includes satellites, AWACS, long range radars,Aerostats,etc.
b) Reach. Having seen,we should be able to reach first & farthest. This capability includes long range ac, escorts, aerial refueling, BVR wpns, Nav Systems,etc.
c) Hit. Having reached, when required, we should have the capability to hit hard & accurately. This involves Air-surface wpns, PGMs,LGBs,etc.
d) Protect. We must also have the capability to protect our force all the time both in peace as well as war so that we are capable of carrying out effective operations. This includes Air Defence, camouflage, concealment, electronic warfare,cyber warfare; etc. This pillar of capability is equally important.

17. HR. Capability is not only about machines or hardware. It is the people who convert this capability into actual power. Therefore, HR is a vital function. Manning, recruiting, trg, skill development, retention, etc.

18. Finance Thereafter, depending on budget allocation, the various capabilities are prioritized over 3-4 Plan periods.

19. As our capabilities evolve, we expect our potential adversaries to also try and keep pace matching up with us. Today we may have superior conventional warfighting capabilities and effective nuclear deterrence against a potential adversary, but a favourable capability balance is not static. At each stage we should be able to conduct prompt, sustained and synchronised operations tailored to specific situations. In addition we should have access and freedom to operate in all domains – space, air, land and sea and most importantly, the information domain.

20. The problem is that this transformation is a long drawn process. It can't be achieved overnight. Long drawn because of our type of set-up. It is not a single condition to be achieved, nor is it like a normal evolution. Transformation for us will be a continued series of fundamental changes each leading to a better capability. Keeping all this in mind, we need to understand what we need for our capability build-up.

Crystal Gazing; Future Aerospace Power.

21. In my opinion, aerospace power will proliferate & find utility with many more agencies. Because of its inherent flexibility & rapid response, it will become the preferred tool for many more contingencies. It will be able to offer up more options to the leadership in times of national crises. But the same pluses will raise fundamental questions of management, policy, org structures & ownership.

22. Aerospace technologies will continue to evolve creating exciting possibilities. Revolution in Engine design & Artificial Int has already commenced. Technologies for int gathering & Surveillance will leapfrog generations ahead. Instrumentation, metallurgy, comn & computing power will be revolutionized. Wpns capable of directed energy & controlled destruction are already being tested. Non-lethal air launched wpns are on the cards.

23. Aerospace Power will seek to enhance its fundamentals of reach, accuracy, lethality, survivability, comd & control. More complex situations will witness increased employment of Remotely Piloted

Ac(RPAs). Peacetime employment of aerospace power will increase. It will be interwoven into the fabric of homeland security in many more roles for tackling asymmetric forces.

24. Increased use of Space by the 'Have's' will be a distinct advantage in conflicts. Even in a 'No Conflict' situation lack of 'Space' will reduce 'bargaining' or 'negotiating' power. Guarding or protecting Space assets will become a high priority area.

25. With rapid developments in IT, Nano Tech,Directed Energy, Electronic & Cyber warfare & ISR it is difficult to predict the nature of Aerospace Power in, say, 2050:-
    a) Will the whole accent shift to RPAs ?
    b) Will 'Space' ops become routine & user friendly ?
    c) Will supersonic or hypersonic transitions become routine ?
    d) What limits to miniaturization ?
    e) How to integrate Space with air, land & sea?

26. These are questions with tremendous consequences. Systems which were dreams only 10 years ago are already being operationalised. So if this be the future, what do we need to do to ensure we are there, up front ?

What Do We Need To Do

27. Policy. We need a comprehensive National Strategy on Aerospace spelling out where we go. We need to institutionalize the process so that there are minimum changes. We need a regulatory mechanism with teeth for implementation of the strategy like the Federal Aviation Authority. This must have representation of all stakeholders. A change in the mindset of policy makers needs to be brought about. They must feel they, too, are stakeholders & not disinterested observers.

28. Technological Base. Enhance Tech trg by having more IITs & Tech Institutes with access for deserving students. Enhance & retain our pool of expert manpower. Today they are in USA, UK, Singapore.

29. Industrial Base. Encourage the concept of 'Brand India' with quality consciousness & control. Empower Pvt Sector by encouraging JVs & ensuring suitable policy changes to make it financially viable. We need to institutionalize these changes to prevent reversals & ensure user commitment. In return, Pvt sector must commit to put money where the mouth is.

30. Acquisitions & Offsets. In the next 10 years we are likely to spend 235 bn USDon acquiring Defence systems. Even at 30% offsets it amounts to a whopping $80 bn.First we need to understand offsets & then exploit their potential. Countries likeBrazil & s Korea have used 100 to 120% offsets. We need to redefine offsets. Make the definition broader. One point to remember here is that offsets never fetch you cutting edge technology. It is always better to pay up front. Today our acquisitions process is slow. It needs to be streamlined. Involvement & accountability at ministry levels needs to increase to avoid delays.

31. R & D. There is a crying need to invest more in R & D, not only by the Govt but by the Pvt & Public sectors too. The running of DRDO must be streamlined to minimize wastage & to get a better bang for the buck. The accountability of DRDO needs to increase. They must set timebound, achievable objectives. We should also lay emphasis on allocating broad based research to renowned educational institutions.

32. Organisational Changes. We need minor modifications in the org aspects. I have already discussed an autonomous FAA like structure. We need to simplify processes & procedures. On the military side we need to effect two changes. The first is the formation of a Space Comd. This will be tri-Service. However, manning must be as per Service requirements & skill levels instead of the standard 8:2:3 for army, navy & AF. The second is Air Defence Comd. This, again must be tri Service. It must be headed by the AF since AD is the prime responsibility of the IAF. With suitable representation from other Services & agencies.

33. National Will Last but not the least. The message must spread that this is not only a military or Govtal issue. The spinoffs will benefit the entire Nation. Hence the whole Nation must feel that it is a stakeholder.

Conclusion

34. There is no doubt that aerospace power is the power of the future. We must, therefore, invest in the Power & the Technology. We need to spread this awareness to the Nation. Policymakers need to appreciate that they are stakeholders too. We need to institutionalize policy guidelines to prevent reversals of decisions. We need to create an environment that facilitates Pvt & Public sector participation.

35. Today we are at the cusp of our capabilities. The ramping up will start in 2015. We do have 3-4 years to prepare. If we use them wisely, we will be there, right near the top, in a strong position to exploit this great medium of Aerospace.

Air Chief Marshal PV Naik (Retd)

Air Chief Marshal PV Naik, PVSM VSM was born on 22 July 1949 and commissioned into the Indian Air Force on 21 June 1969. After initial schooling in the Sainik School, Satara, he graduated with the 33 course from the National Defence Academy.

In a distinguished career spanning forty years, the Chairman COSC and CAS has flown a wide variety of combat and trainer aircraft. After initial training on the HT-2, he has flown the Vampire and the Hunter, and has had extensive operational experience on all variants of the MiG-21. He is a Qualified Flying Instructor with vast instructional experience and a Fighter Combat Leader from the prestigious Tactics and Air Combat Development Establishment (TACDE). He was selected as one of the first eight pilots to convert to the MiG-23 BN in the erstwhile USSR, and was responsible for its induction into the IAF. Besides commanding a front line fighter squadron, he has commanded an important fighter base and air force station at Bidar. He has been the Directing Staff at TACDE and the Defence Services Staff College.

During his career, the Air Chief Marshal held numerous important staff appointments in different headquarters. He was the Senior Air Staff Officer at HQ Western Air Command, the Air Officer Commanding-in-Chief of Central Air Command and the Vice Chief of Air Staff, prior to his appointment as the Chief of the Air Staff. He also took over as the Chairman, Chiefs of Staff Committee on 01 April 2010.

The Air Chief Marshal is a graduate of the Defence Services Staff College, and an alumnus of the National Defence College. He is a recipient of the Param Vishisht Seva Medal and Vishisht Seva Medal.

Indian Global Navigation Satellite System (GNSS) – Paradigm

Dr Surendra Pal

Abstract

Determination of position and time with greater accuracies is the need of the hour. Satellite based services:Global Navigation Satellite System (GNSS), a vast system of systems, provides positioning, navigation and timing information to scores of users in oceans, land, air and even in space. This article traces the history of navigation, evolution of navigation satellites, the present constellations and world scenario. India has taken a significant step in this direction, with its operationalization of SBAS system GAGAN and deployment of its own Regional Navigation Satellite Constellation (IRNSS). The article dwells upon the various GNSS connected aspects, their applications and the Indian perspective.

Navigation

Navigation, perhaps, is the only science and technology associated with early man from immemorial days. Navigation is the science of chartings one's own route from point 'A' to point 'B' with respect to known references, both in spatial as well as in temporal domain. Identifying and remembering objects and landmarks like rocks, trees, rivers, markings on trees or leaving mile stones/ flags and looking at stars, sun and moon, as points of reference as navigation aids were used by early man to find his way in jungles, deserts, mountains etc.

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 19–43

The time reference was day/night or even could be seasons. In sea or large lakes to start with : near shore land marks, sea weeds, birds, ocean currents, islands, smells and of course celestial visible objects like Sun, Moon, Pole Star and some constellations like Great Bear etc. were used as navigational references.When moved far-away places latitude, longitude height and time references were required.

"Navigation" word has its origin in 'Naoka' –'Nav' boat – 'Gati'-Velocity in Sanskrit.

History of Navigation:

Phoenicians, Vikings and Greek were undertaking sea voyages and had great navigational skills even 3000 years back. Phoenicians claimed to have circumnavigated Africa from Red sea, sailing via the Cape of Good Hope. Burning fire on mountain tops were used as light houses. The legendary Light House of Alexandria was an example. Not much is written in the modern history about Navigation activities in Asia-Pacific region. Chinese, Arabs etc., had under taken lots of sea voyages. In Mohanjadaro ruins (Indian sub continent) one clay tablet was found which depicted a boat. Sindhu or Indus valley civilization ruins (parts of Pakistan and in India: Gujarat, Haryana) do show that perhaps a successful business existed with Romans, Babylonians and Sumerian civilizations. Out of 18 Tamil Sidhas, Sidha Bhoganathar is believed to have gone to China via sea route (even he is supposed to have designed an aeroplane) and lived in China as Lao-tzu, spread Taosim. He is attributed to have great navigational skills.

Fig. 1

कर्तुं यच्च प्रभवति महिमुच्छिलीन्ध्रामवन्ध्यां तच्छ्रुत्वा ते श्रवणसुभगं गर्जितं मानसोत्काः ।
आ कैलासाद्विसकिसलयच्छेदपाथेयवन्तः संपत्स्यन्ते नभसि भवतो राजहंसाः सहायाः ॥११॥

Having heard your thunder, pleasing to the ear and which causes the Earth to abound with mushrooms and to be fruitful, the royal geese, yearning for Lake Manas, bearing pieces of lotus roots as victuals for the journey, will fly together as your companions in the sky as far as Mt. Kailasa (Meghdoot, Volume 1, Verse 11)

Fig. 2 Archeological site at Lothal (Gujarat) has got remains of a port which indicates that more than 4500 years back India had advanced sea transport system. The dock is almost of the same size as that of Visakhapatnam, modern port.

The great Sanskrit scholar Kalidas (4th century A.D) was the first one to imagine above land navigation. In his famous Sanskrit composition `Meghdoot' [Fig 1], Kalidas's Yaksha instructs `Megha', as how to navigate from Ramagiri to Alkapuri. He used complete Bio-Sphere as Navigational Control Points.

Position Determination Evolution:

Not much is recorded about early tools used for navigation. However some historical evidence suggests that Egyptian Groma, Cross Staff and Astrolab were used for noting the star position. Traverse boards were used for charting the return route, minute/hour sand or water glasses along with equidistancedknotted ropes, and logs were used for boat speed/velocity measurements along with the dead reckoning techniques. These tools were handy (from 14th – 16th century) till compass for direction finding was invented.From 17th to 20th century chronometer, sextant, compass.Beginning of the 20th century Radio Ranging were used, that included HF/VHF/radio communication, Radars, DME, ADF, NDB, VOR, Hyperbolic Navigation Systems : GEE, DECCA (70 to 128 KHz), ALFA, BRAS-3, R-10 and LORAN-C (90 to 110 KHz) the Land Based Radio Position System.In 60-80's the space based system like Transit, SECOR, TSIKAD etc and then GPS and GLONASS came to be used for 3D position determination.[Fig. 3 gives pictorials depiction of the progress].

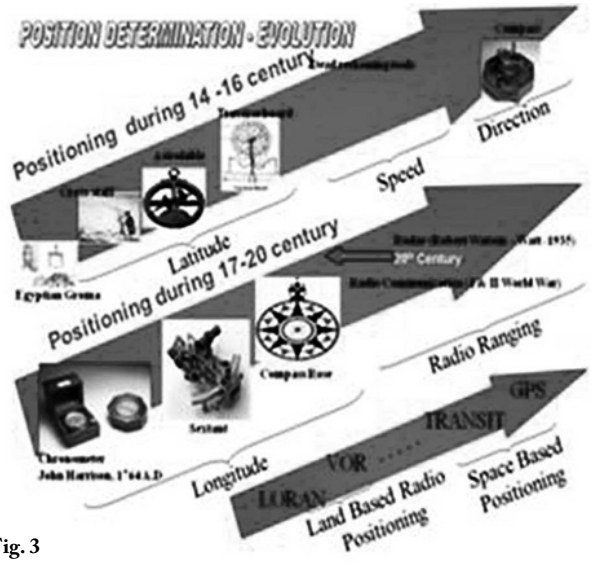


Fig. 3

During the primitive stages of navigation [Fig.3], it was possible to fix the latitudes with various techniques mentioned earlier,however fixing a longitude was a tough job, in want of an internationally accepted reference or prime meridian or 0^0 longitude since earth is almost spherical. There were no good, accurate and authenticated maps. The

situation became more complicated in want of accurate time measuring clocks and reference. Clocks with Pendulum, water/sand hour glasses etc were affected by humidity, gravitational changes, ship movements, temperature changes, above all poor reliability with high drift rates and want of prime meridian as reference, made the task of sea voyages extremely difficult and risky. The sailors used to move more because of good luck, rather than navigational tools or skills. The biggestrecorded tragedy is of a single accident on Oct 22, 1707, at the Scilly Isles near the south western trip of England, four home bound British warships under the command of Admiral Sir Clowdisley Shovell ran aground and nearly two thousand men lost their lives. Shocked by such accidents the BritishParliament in its famed longitude Act of 1714 AD' set the highest award/reward of that time, naming a prize equal to £ 20000/- for a "Practical and useful means of Determination of Longitude using a Chronometer". English clockmaker John Harrison, a mechanical genius took the challenge and pioneered the science of portable precision time keeping, made the Choronometer excelling the requirements, in 1764 AD. This chronometer changed the pace of navigation as it was only used to lose less than a second in 24 hours, even in voyage undertaken in high seas.

Time keeping is an important activity since one degree of longitude equals FOUR minutes of time the world over and distance at equator is 68 miles virtually become, a point at poles. This called for fixing a prime meridian reference (0^0 Longitude). Fig 5 gives an idea of accuracy, where now we are looking for picoseconds accuracies. If we lose one nanosecond, the error in positions is 30 cm.

In the year 1884 AD at the International Meridian Conference held in Washington DC, 26 Countries voted to make the common Prime Meridian and Greenwich Meridian as the prime meridian of the world. This also became the GMT.

Satellite Based Navigation

With the launch of Sputnik in 1957 the era of space based navigation and communication started. Scientists of the John Hopkin's University. AppliedPhysics Laboratory whostudied the signal and Doppler shift, were able to predict theorbit.Thisgavebirthto the ideathat ifephemeris of satellites are known than observer position can be determined by Doppler measurement. Early space based systems (The US Transit and Russian Tsikada) provided two dimensional high accuracy positioning service. However, the frequency of getting a position fix was dependent on the user's latitude. Theoretically at equator the

frequency was ≈ 110 minutes while higher latitude the frequency could be tens of minutes. The fixing and processing also needed ≈ 20 minutes. This was suitable for marine applications but not for air vehicles. Air based systems needed faster and also the 3D positioning .However for 3D measurements and increase in accuracy, clock was to play an important role along with tones and Doppler measurements in Transit, Secor, Tskylon, Tiskada and Timation (forerunners of GPS). The s/c 621B used PRN codes. The future satellites were provided with atomic clocks. By 1978 all efforts of various US agencies were merged and NAVSTAR or GPS programme came in to existence. USSR developed the GLONASS constellation and both were fully operation in 1998.

Position Fixing

The position determination with reference to: three predetermined locations, fixes the accurate position of an individual, using the well known triangulation technique.***[Fig. 4]***

However there are errors and time biases in the measured range called PSEUDO range. To remove this we make measurements with respect to FOUR references. In satellite navigation scenario the four references are the spacecrafts in orbit whose ephemeris are accurate and well known. Three s/c are used for determining the three unknowns of position while the fourth one is used to 'removed of bias particularly related to time. Errors are also introduced due to

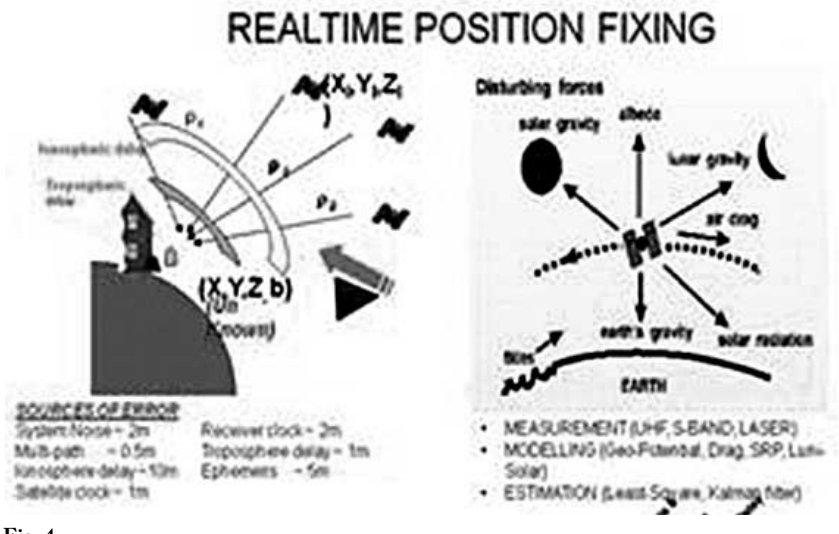


Fig. 4

iono, tropo, multipath etc.

During the planning of GPS and GLONASS it was consciously decided to go for 'L' band, [Fig 5 - b] frequencies, where the background microwave noise is minimum. To give a global coverage, satellites were put at 19000 kms to 22000 kms in multiple planes, above VanAllenradiation Belts,US-GPS Programme decided to use three planes, same frequency but with CDMA and different satellite codes, while GLONASS used six planes and FDM multiple access techniques. It also provided ≈12 hours orbital period with longer visibility. The satellites were small with short appendages likes solar panels etc. so that solar and Luni radiation pressures do not impact the orbits. Minimal and essential orbit maintenance manoeuvres were planned so that orbits remain stable. Onboard isoflux antennas with precise known location of phase centres were designed and employed. The range obtained from four satellites is PSUEDO range. The errors due to iono, clock, ephemeris, tropo, multipath etc. are estimated and removed [Fig. 4]. To get good GDOP (Geometrical Dilution of Precision) one should have widely separated satellites enclosing large volumes. [Fig 5 - a]

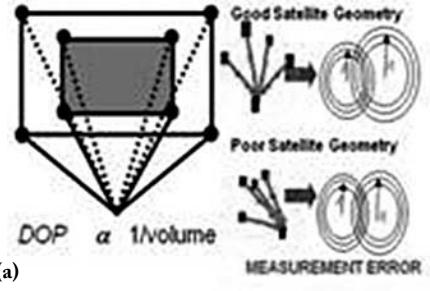
Satellite Constellation Design Parameter

Orbit Characteristics

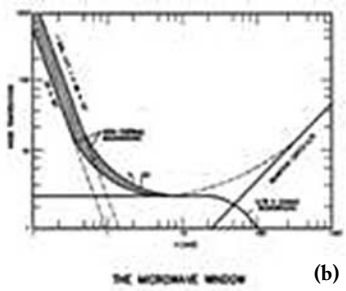
- Orbital Height >= 20,000 Km
  - Longer Visibility
  - Orbital Period
- Perturbations(Minimum)
  - Solar Radiation Pressure (Impacts Eccentricity)
  - Luni Solar Forces (Impacts Inclination)
- Dilution Of Precision And Impact On Position Accuracy
- Position Error Is A Function Of: DOP & Measurement Accuracy

Communication

- Antenna
- ISO FLUX (More Than Earth Disc)
-
- Frequency - L Band
- Minimum Background Thermal Noise
- Minimum Pathloss
- Minimal Ionospheric Group Delay
- Minimal Attenuation
- Modulation: CDMA/FDMA/BPSK



(a)



(b)

Fig. 5

Present Scenario

Presently GPS and GLONASS constellation are fully operational andGALILEO (European Union) has launched 20 satellites and Chinese 23 satellites. There are two regional constellations – **Indian Regional Navigation Satellite System (IRNSS) [7 – Satellites]** while Japanese QZSS [1 satellite] are in orbit. There are four operational Space Based Wide Area Argumentation System, augmenting the GPS Constellation: WAAS (2s/c), EGNOS (2 s/c), GAGAN (Indian) (2+1s/c), MSAS (Japanese) (one). These help seamless civil aviation activity across the globe ($\approx \pm 50^0$ N/S). Russia is planning SDCM System for GLONASS.

GNSS Scenario

- 4 Global Constellations:
- GPS (24) & GLONASS (29) fully operational
- Galileo (30)–20 satellites are operational
- Beidu (35) – 23 satellites are operational
- 2 Regional Constellations:
- IRNSS (7) – 7 satellites are operational
- QZSS (7) – 1 satellite is operational
- GNSS (SBAS) Augmentations:WAS, GAGAN, MSAS & EGNOS

The world wide trend is to have a multi-constellation system with multi frequency receiver developments, so that one can have improved availability, accuracy and multipath mitigation. The dual and triple frequencies are available for civilian users with added iono corrections. There is an effort towards having systems with improved resistance to jamming and spoofing. The modernized signals of GPS/Galileo/GLONASS and even IRNSS will provide faster Time to First Fix (TTFF), weak signal tracking and acquisition, indoor positioning (Assisted GPS), messaging, improved multipath, search and rescue, disaster warning and even environ monitoring.

Indian GNSS Paradigm

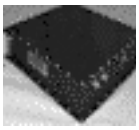
Satellite Positioning System (SPS) receiver development of ISRO started in 1996 to determine orbits of low earth satellites accuracy First SPS was used On Board IRS-P4. In-house orbit determination software SANGAM wasdeveloped and used successfully. SPS is a regular phenomena onboardall Indian low earth orbit satellites. The orbital predication has become quite accurate and easy, better than 50M. The system was developed jointly by ISAC/ISRO and M/s Accord Software [Fig. 6, 7]. Fig 8 depicts the performance of SPS over years.

Description	Specification	Remarks
Type of System	GPS Receiver, L1, C/A (6/8/10/12 Channel SPS) L1 C/A, L2C & GAGAN (21 Channel SPS)	In Future, this could change in a Multi-GNSS environment
No of Channels	6/8/10/12/21	More Channels need More On-board Resources
Time To First Fix	480/100/85/80 (Sec)	Faster is Better
Velocity	± 10 km (Doppler range of about 100KHz at L1 frequency)	LEO Satellites typically orbit at 28,000 km/h speed
Acceleration	5g	High during launch/re-entry. On-Orbit much lesser.
On-board storage	2 Orbits Data	Down linked at 16 kbps through a Ground Station
S/C Interface	MIL-1553B or Serial	Mission Requirements

Fig. 6 Major Specifications of SPS

GNSS- based Satellite Positioning System

- GNSS Receiver is used to compute precise orbit of LEO satellites.
- The major challenges are
  - ▸ Very high velocity
  - ▸ Wider visibility angle
  - ▸ Frequent memory/data corruption
  - ▸ Auto-recovery
  - ▸ 24/7 operation for many years
- Specialized acquisition tracking algorithms, dual-redundant dissimilar hardware, screening and special processes are used to meet the above challenges.
- GNSS-based SPS are successfully flown since 1999 in many missions including IRS P4, TES, IRS P6, IRS P5, CARTOSAT, SRE, Ocean Sat etc.
- Further GNSS Receiver is used in the PSLV launch vehicles starting from C8.



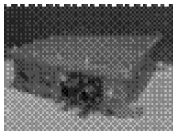


Fig. 7

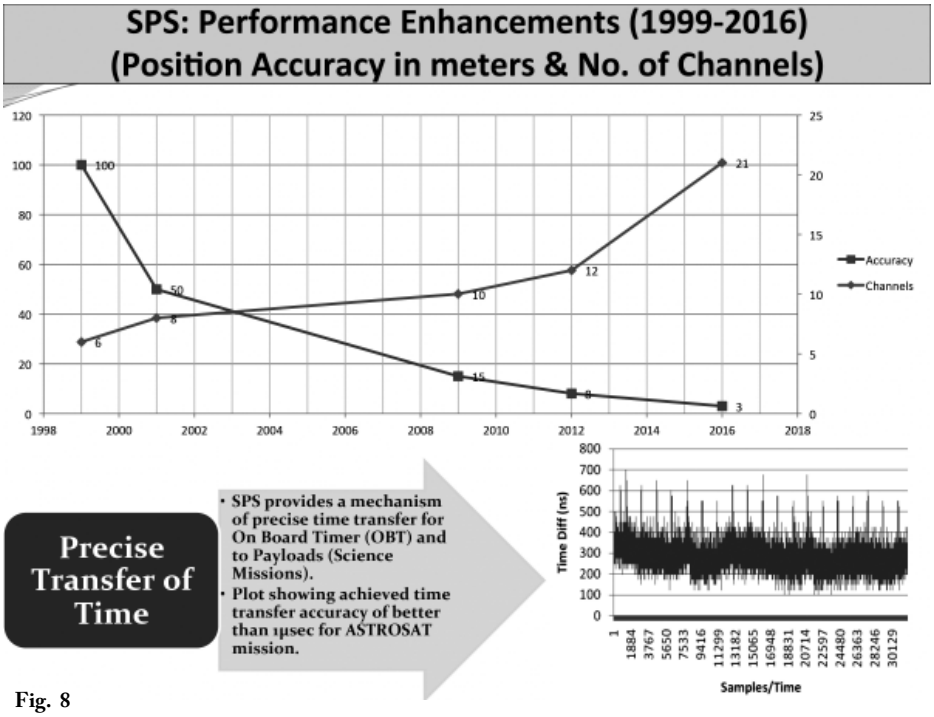


Fig. 8

Satellite Based Augmentation System (SBAS)

Studies were undertaken by ISRO along with AAI in 2001. GAGAN (GPS Aided Geo Augmentation Navigation) project was formed in 2003. Technology Demonstration System (TDS) was over in 2007 and Final Operational Phase (FOP) spread over years 2009 to 2013. GAGAN got certified for APV1.0/1.5 in April, 2015. GAGAN system is an open system available to everyone, free of cost. The system transmits GPS like signal with all corrections to the user receiver so that majority of errors are removed. GAGAN accuracies are much better than many DGPS system. (Fig. 11 gives a comparison of positional accuracies of various places in India using GAGAN and GPS receivers respectively,observed, over 24 hours.) Fig. 14, 15 and 16 depicts the capabilities and achievements of GAGAN. GAGAN system is equipped withL-5 frequency corrections, for taking care of modernization of GPS.

INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM (IRNSS)

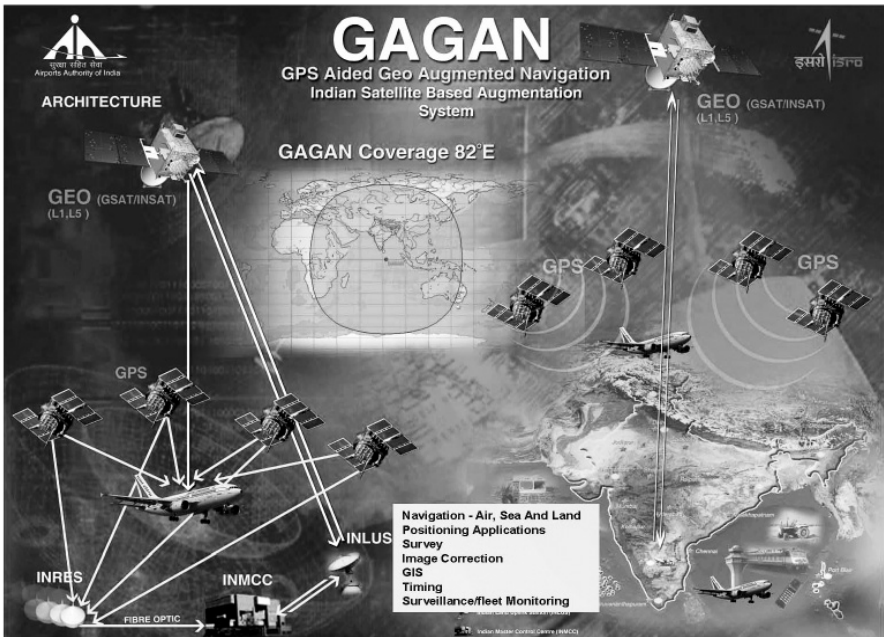


Fig. 9

Since GPS and GLONASS are controlled by US and Russian defence agencies, with a warning that services may be denied to adversaries. For security reasons, India decided to develop its own navigation satellite system to keep in pace with the emerging geopolitical situation, where besides GPS, GLONASS, QZSS, GALILEO, China's Compass and Beidu satellites systems are getting deployed.

Initial Studies were undertaken in 2003. Project formulation was completed in 2006. First IRNSS satellite was launched on 1st July, 2013* the full Constellation of seven satellites was completed on 28th April 2016. An exhaustive collaborative studies and efforts have been continuously undertaken with GPS, GLONASS, EGNOSS/GALILEO and JAXA. Ionospheric and Tropospheric – Studies and modeling were undertaken and that resulted in to development of a special ionospheric model for ionogrids both for GAGAN and IRNSS, so that obtained position accuracies are much better than obtained from stand alone GPS receiver.

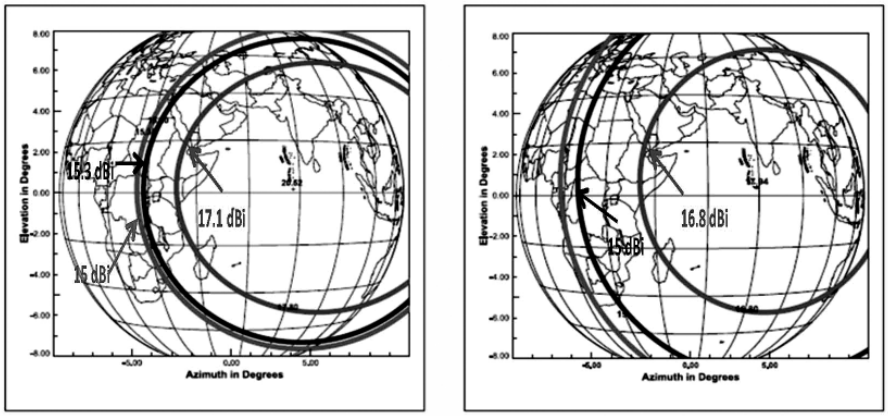


Fig 10 GAGAN Payload L1 & L5 band coverage contours

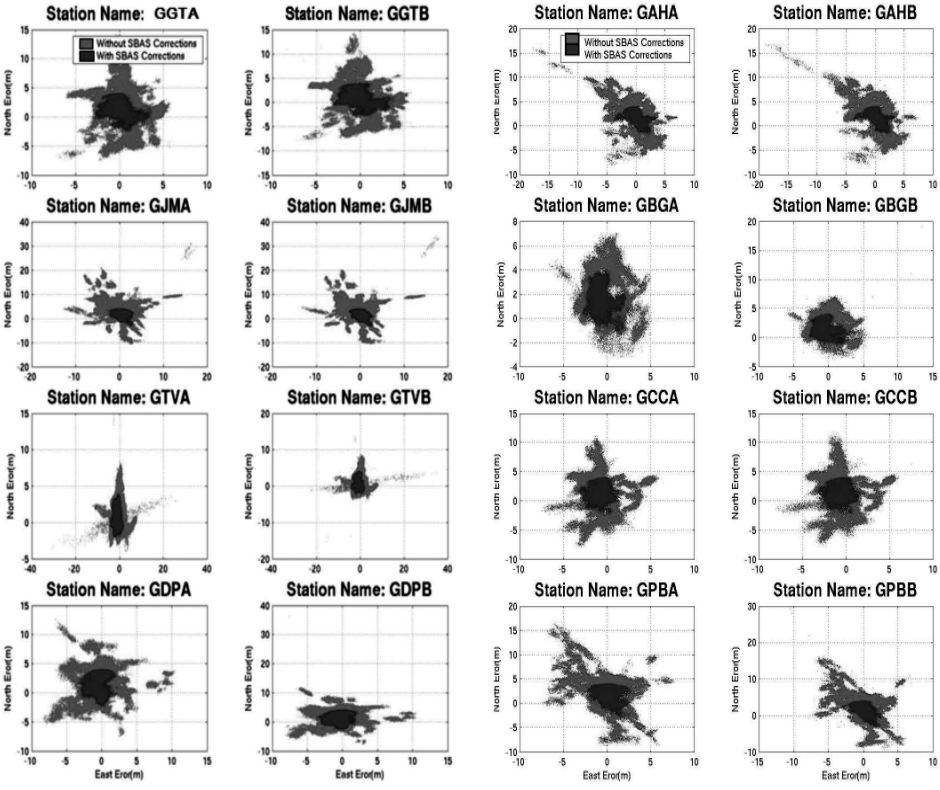


Fig. 11 : GAGAN TDS Position Plots for 24 hrs using GPS & GAGAN enable receivers respectively

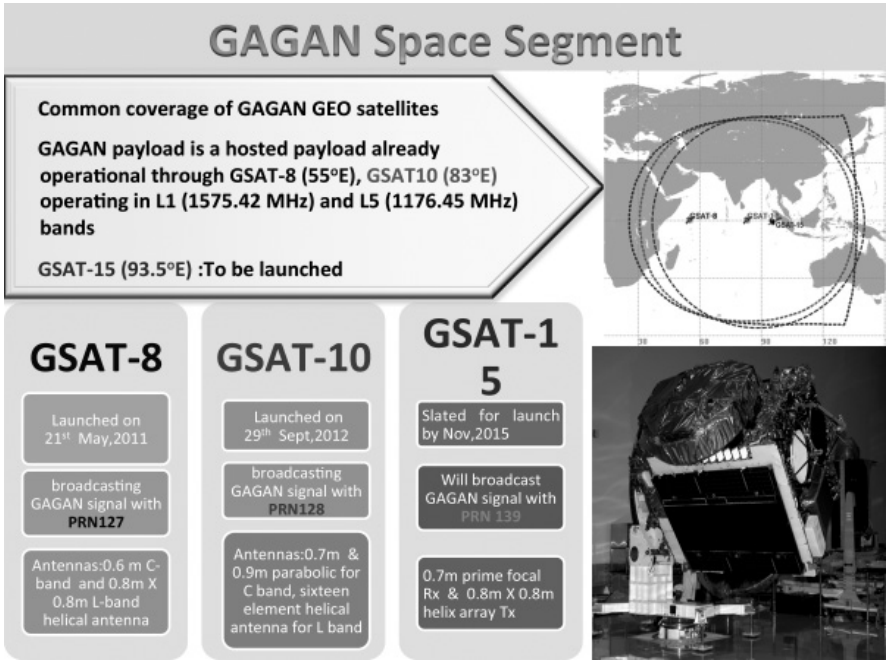


Fig. 12 GAGAN Space Segment

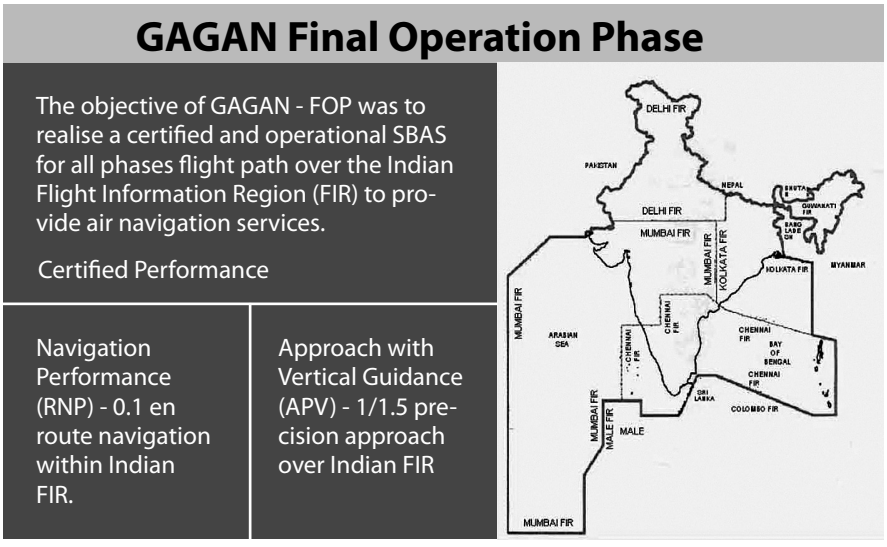


Fig. 13 GAGAN Final Operation Phase

Achievement of GAGAN Objective

Service Level	Parameters	Requirement	Results
RNP 0.1	1. Availability	>99 % over the Indian FIR	>99%
	2. Horizontal Accuracy	<72 m 95% bound	0.7m Average
	3. Vertical Accuracy	N/A	1.52m Average
	4. Time to Alarm	10 s	6.2S
	5. Vertical Alert Limit	N/A	-
	6. Horizontal Alert Limit	185.2m	<185 m
APV1/ 1.5	1. Availability	99% over 76% of India	86.57 %
	2. Horizontal Accuracy	<7.6 m 95% bound	0.7m Average
	3. Vertical Accuracy	<7.6 m 95% bound	1.51m Average
	4. Time to Alarm	6.2 s	6.2S
	5. Vertical Alert Limit	50 m	VPL<50
	6. Horizontal Alert Limit	40 m	HPL<40

Fig. 14 Achievement of GAGAN Objective

GAGAN Certifications

GAGAN has been certified by Directorate General of Civil Aviation (DGCA) for the provision of RNP 0.1 and APV 1.0 services.

- RNP 0.1 Service
  Certification: 30-Dec-2013
  Commissioning: 14-Feb-2014
- APV 1.0 ServiceCertification: 21-Apr-2015
  Commissioning: 19-May-2015

3 GEO's GSAT-8, GAST-10 and GSAT-15 carry GAGAN Payload.

Fig. 15

To start with the Indian Regional Navigational Satellite Systems (IRNSS) is of seven satellites, 3 Geo-stationary while '4' are Geo-synchronous, with 29^0 inclinations, to provide good GDOP and position determination accuracies comparable or better than GPS. IRNSS provides the designated services over the

Indian subcontinent + 1500kms beyond Geopolitical boundary of India. If four more satellites added in suitableGeo Synchronous (properly phased) orbits with 29^0 or higher inclinations and proper orbital spatial and temporal phasing can increase both position determination accuracy and coverage in future. [Fig 16 to 18 depicts various aspects of IRNSS]

Due to non availability of spectrum slots in and around L-band, India decided to go by L5 (1164.45 – 1188.45 MHz) and S-band (2483.5 to 2500 MHz) with standard positioning services (SPS) using grid based iono corrections.IRNSS uses BPSK (1) for SPS and it has an encrypted with long code services for restricted users (Restricted Service) with BOC (5,2) modulation.

IRNSS System

Presently the initial phase all 7 satellites are in orbit. Four satellites position determination results are extremely accurate and encouraging [Fig. 19].

IRNSS service area is divided into three regions:

Indian Land Mass

The area encompasses the Indian Geo-Political boundary.

Primary Service Area

The area covered by 1500 km contour from Indian geopoliticalboundary inclusive of the Indian Land Mass.

Extended Service Area

The area between primary service area and area enclosed by the rectangle of Lat 30^0S to 50^0N, Long 30^0E to 130^0E.

IRNSS Constellation

Indian Regional Navigation Satellite System (IRNSS) constellation is developed by ISRO to provide accurate position information to various users in the country. It will also operate in the regions located in 1500 km radius around India. The system is expected to provide position accuracy of better than 20 m.

The applications of IRNSS include disaster management, vehicle tracking and fleet management, integration with mobile phones, terrestrial navigation aid for travellers, visual and voice navigation for drivers and more.

The Indian Regional Navigation Satellite System (IRNSS) consists of three segments viz. Space, Ground and User.

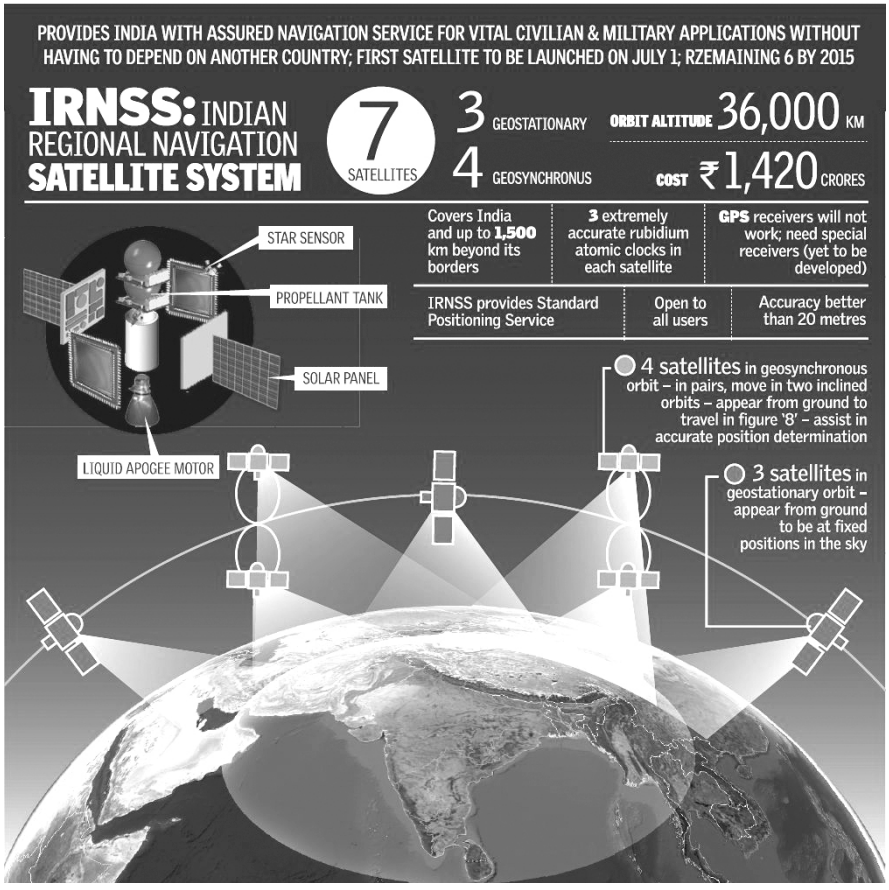


Fig. 16 *[IRNSS – Orbital Positions]*

Fig. 17 *[IRNSS Satellite Communication]*

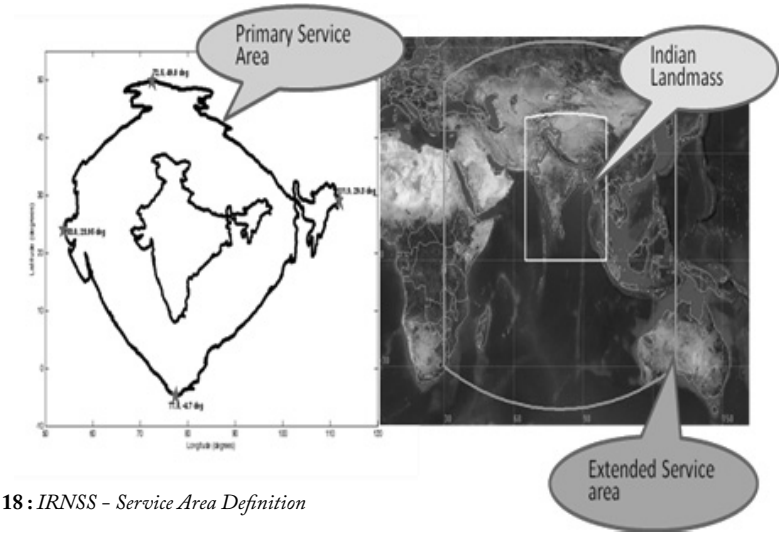


Fig. 18 : *IRNSS - Service Area Definition*

ISRO Navigation Centre at (INC) at Byalalu, the Nerve Centre of the IRNSS ground segment

The space segment consists of a constellation of seven Satellites in phase-1, which is positioned in the following obital slots.

- Four satellites in a Geosynchronous (GSO) with an altitude of 36,000km and an inclination of 29^0 in the orbital position of 55^0 E and 111.75^0E.
- Three Satellites in the Geo Stationary Orbit (GEO) of 36,000 km with an inclination of 5.1^0 in the orbital position of 32.5^0E, 83^0E and 129.5^0E.
- IRNSS - Regional Navigation Satellite System with 4 GSO + 3 GEO Satellites
- L5 and S-band Signals

The IRNSS Signal-in-Space Interface Control Document (ICD) for SPS version 1.0 was released in official ISRO website http://irnss.isro.gov.in in October 2014. The information for user to acquire, track and utilize the SPS navigation signals are available in the ICD.

Currently, IRNSS ground segment is operational on 24/7 basis with 13 Indian Range and Integrity Monitoring Stations (IRIMS), one IRNSS Network Timing Centre (IRNWT), on ISRO Navigation Centre (INC) and one Spacecraft Control Facility (SCF) with its data communication network. The entire ground segment with two more IRIMS and each ofIRNWT, INC and SCF is planned to be completed in future.

IRNSS Uniqueness

IRNSS is an indigenous system – Uses Dual Frequency (L5/S) for Civilian Users and third satellite navigation system (worldwide) to be fully Operational on August 2016, Uses Grid based model for ionosphere delay correction (accurate for single frequency users at L5/S band), S-band for navigation –

first time being used (low ionospheric delay to benefit single frequency users, IRNSS can be used to broadcast short messages (potential to be used also as a Disaster Warning Dissemination System), all satellites are visible over Indian region for almost all the time, RS (Restricted Services) signal for strategic users. Using '4', IRNSS satellite namely IRNSS – 1A, 1B, 1C and 1D – over sixteen hours in a day, accuracies obtained are much better than GPS and comparable or better than GAGAN

IRNSS Satellite Payload Functions and Signals

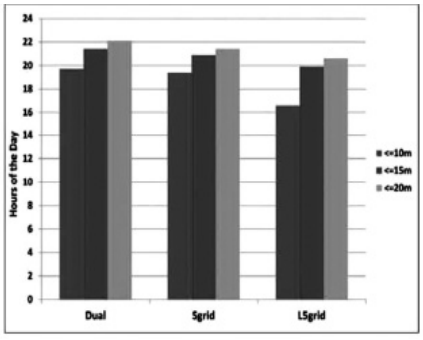
Reception of navigation uplink data through TC, Generation of navigation message, SV time, code generation, code encryption, Spreading codes, modulation, up-conversion, amplification, filtering and transmission, Three signals in each L5 and S Band (SPS, RS-D, and RS-pilot signals, Interplex signal is added to maintain the constant envelope characteristic of the composite signal, The IRNSS Payload nominally transmits signal with SPS (22.2%), RS-D (44.4%), RS-Pilot (22.2%) and Interplex (11.1%) power distribution, SPS signal is BPSK (1) Modulation, RS-D and RS-Pilot uses BOC (5,2) Modulation, Onboard Rb Atomic Clock for Highly Frequency Stability.

GNSS and IRNSS Applications

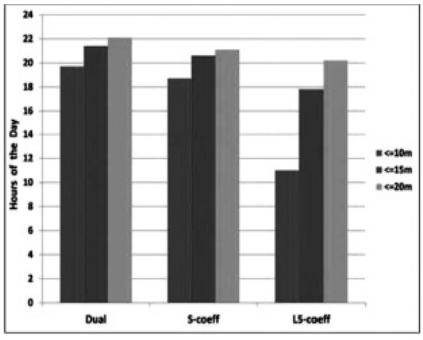
GNSS Application Areas

Defense Applications of IRNSS

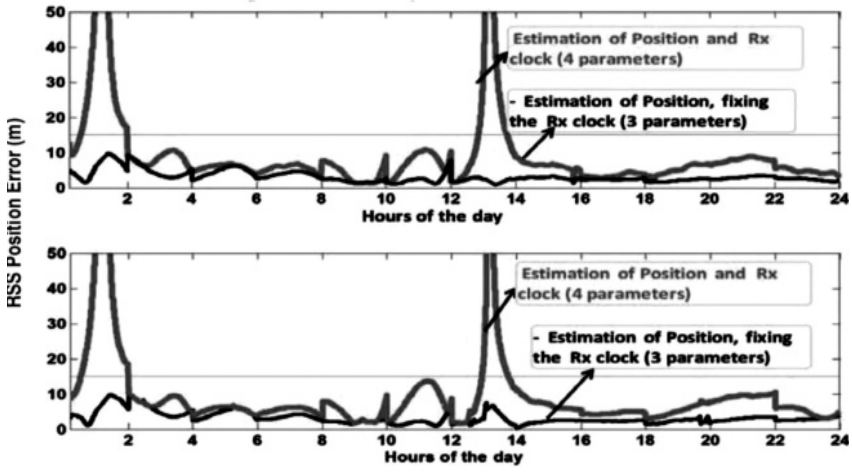
Maritime, Aeronautical and Terrestrial Navigation, UAV and Aerial Delivered Weapons, Gun, Mortar, Launcher Alignment and Short Range Weapon Navigation, Aid to Inertial Navigation, Precision Timing Applications, Synchronizing Secure Radio, Synchronizing Communication Networks, Timing of Navigations Parameters, Launch Complex Synchronization, Marine, Aeronautical and Terrestrial Navigation, UAVs and Aerial Delivered Weapons, Gun, Mortar, Launcher Alignment and Short Range Weapon Navigation. IRNSS has a short messaging system for fighter pilots. GAGAN can help defence services pilots to fly to areas where presently no navigational aids are available. One may be able to use some the remote and non-functional airstrips whose number in India is >200.



Position errors for single-frequency user equipment using grid-based corrections compared with dual-frequency receivers



Position errors for single-frequency user equipment using coefficient-based corrections compared with dual-frequency receivers



RSS Position Error at Bangalore and Bhopal Reference Stations with 4 IRNSS Satellites

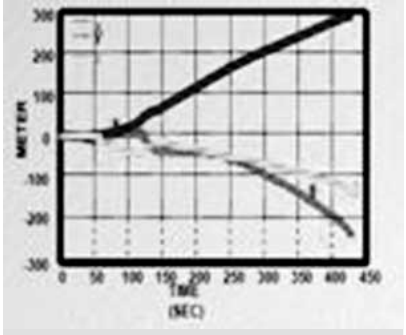
Fig. 19

IRNSS Signals, Services & Accuracy

Service Type	Signal	Frequency	Accuracy
Standard Positioning Services (SPS)	BPSK (1)	L5 (1176.45 MHz) S (2492.028 MHz)	Single Frequency < 20 mtrs
Restricted Positioning Services (RS)	BOC (5,2)	L5 (1176.45 MHz) S (2492.028 MHz)	Dual Frequency < 10 mtrs

Fig. 20

Satellite Navigation Aided Inertial Navigation System



(INS Pure Navigation Performance)

In Weapon System, Primary mode of Navigation is the Inertial Navigation System (INS), Inertial Navigation: It is a process of measuring movements of a vessel based on sensed acceleration in known spatial directions, Gyroscopes, Accelerometers, Electronic computers.

Civilian Applications of IRNSS

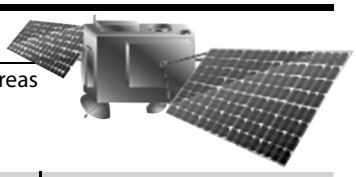
IRNSS based Disaster Warning System

Agencies like IMD, INCOIS, CWC etc. can generate disaster related alerts, Alerts transmitted via VSAT network to INC, Alert message will be uplinked to IRNSS Satellite by TT and C Centre, IRNSS navigation message structure can transmit certain short messages, short message can be received by all INRSSUser Receivers.

BENEFITS FOR 170 PROJECTS

Use of space technology as force multiplier in other areas

Government identifies 170 projects where space technology can be used for better result



KEY AREAS

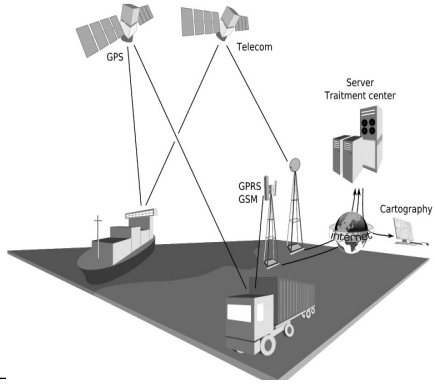
- Ganga Cleaning Mission Mapping the river bed and entire river basin
- Crop forecasting
- Identifying potential fisheries zones
- Wasteland development
- Preparing master plan for cities
- Satellites to provide critical data on natural resources of the country
- Environment impact Assessment
- BIG (BHUVAN+IRNSS+ GAGAN)
- Forest fire alert system
- Forest cover monitoring
- GIS based infrastructure planning
- Geo-morphological mapping for mines
- Mapping for protected areas and coastal zones
- Top information system for national highways
- Site management plan for tourist places under ASI, geo-tagging and 3D
- Feeding into the flagship program of India
- Visualisation
- Water bodies and ground water prospects mapping
- Traffic control, scientific research and security agencies
- Disease surveillance
- Micro and mini irrigation and agricultural projects
- Micro and mini farming
- Weather and ionospheric studies
- Geo dynamics

Fig. 21

Road Navigation

Road Navigation, Tracking, Tracing and Scheduling Vehicle Routing, Remote Condition Monitoring, Fleet Management, Intelligent Transportation System, Speed, Emission Control, Load Monitoring, Safety and Security, E-tolling, PAYD Insurance, Accident Reporting, Working time Directive.

- **Improved operational efficiency**
- **Improved customer care**
- **Reduction of theft risk**
- **Facilitated Fleet Maintenance**
- **Enforcement of Transport Regulations**
- **Tracking Hazardous Goods**



Fleet Management

Rail Transportation

Train control, Signaling, Traffic information, Transportation of dangerous goods (Real time track surveying, performance monitoring and condition monitoring), Prevention of collision, derailments and rails switch errors, Asset monitoring and location, Increase capacity and efficiency, Equipment location awareness, Automatic track survey and inspection, Time synchronization of communication systems.

Automatic Train Tracking System

For Indian Railways (12000+ Trains), Technology used: IRNSS, MSS, GSM/GPRS

Maritime

Observing sea level changes, Dredging operations, Wreck locations, Laying pipe lines, SAR of sinking vessels, Positioning of oil rigs, Prevention of piracy, Automatic Identification System, VMS (Vessel Monitoring System), Coastal Surveillance, Maritime domain Awareness.

Coastal Surveillance

Tracking of ~ 2.5 Lakh small boats (< 20 m) in Indian Coastal Region, Coastal security and Maritime Domain Awareness (MDA).

E-CALL (Emergency Calling)

Vehicle automatically dials E-CALL (emergency number) in case of an accident, Sends IRNSS co-ordinate to emergency service, Sends vehicle data (point of impact data), Improves response time.

Transportation

Space Exploration

Indian Launch Vehicles, Space shuttle tracking, Inter-planetary navigation, Re-entry and landing of space missions, International Space Station (ISS), Orbit and attitude determination of spacecraft.

- **Apply fertiliser/ pesticides where and when they are required**
- **Farm by day and night**
- **Autonomous vehicles**
- **Less soil compaction/ more productivity**

GNSS for Agriculture

Emergency Location

Car mounted with GNSS Receiver and Cellular Telephone, Micro-computer monitors airbag deployment system installed in car, If the air-bag is deployed, the micro-computer calls service center over cell phone, Service center passes information to the local emergency services who can respond to the emergency.

Surveying

Land (Cadastral, Construction, Mapping and Mine Surveying, Marine (Hydrographic and Offshore Surveying), Currently Professional Surveying Receivers use all available GNSS signals (multi-constellation and multi-frequency) and other differential correction technique (e.g. SBAS, RTK, DGPS).\

Time Synchronization of Power Grid

Monitoring of Structures and Environment

Bridges, Towers, Dams and Reservoirs, Rail and Road Networks, Sky Scrapers and High Rise Buildings,Foundations, Mines and Quarries, Power Stations, Historic Buildings and Landmarks, Landslides, Earthquakes / landslides, Flood Risk and extents.

Disaster Management and Support

Disaster assessment, management and prevention, Monitor possible danger situations that may cause disaster (e.g. monitor flood levels, tsunami prediction, earthquake), Rapid emergency communication, Rapid command schedule.

Atmospheric and Ionospheric Studies using IRNSS

Ionospheric Monitoring and Scintillation Studies, GNSS Tropospheric Effects and Meteorology, GNSS Reflectometry (GNSS-R), GNSS Radio Occultation (GNSS-RO).

Location-Based Services (LBS)

- **Amenities:** Closest hospital, Filling station, Nearest restaurant, Shopping mall
- **Weather:** Current weather at the location, Temperature, Possibility of rain
- **Topology:** Landform, Height from sea level, Nearest river, Lakes, Mountains etc.
- **Entertainment:** Any sport event near the location on date, Theatre halls etc.

Conclusion

After all, we need measurements of space and time for almost all our activities and GNSS provides these.

For the emerging civil aviation scenario (less than 5 years), all users will need accurate PNT services. All these will be provided by GAGAN IRNSS, which in future do have potential to expand.

Hence, GNSS will influence our life more than any other technological advert.

Dr Surendra Pal

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Kingdom of Saudi Arabia's "Vision 2030"

Shri Shrinivasrao Sohoni, IAS (Retd)

The Kingdom of Saudi Arabia (KSA) is the home of Islam's holiest places attracting millions for Hajj and Umra, and, as the world's largest producer of oil as well, a formidable force in intercontinental politics and the global economy.

KSA is now, however, at a critical juncture. A variety of inter-connected factors are germane to the Kingdom's economic, social, political, and security viability. Some of these are: Oil production and pricing; Saudi-Wahhabi phobia and enmity vis-à-vis Shi'i sects, the Shi'i Islamic Republic of Iran, and President Basher Al Assad's regime in Syria; operations of the so-called 'Islamic State of Iraq and Syria' (ISIS); Extremism, Terrorism, and conflicting Insurgencies; and the aggregate tension, volatility and uncertainty.

Following the death of King Abdullah, the ascent of King Salman bin Abdul Aziz al Saud to the Saudi throne in January 2015 brought the hands of his son, the young Prince Mohammad bin Salman, to the helm of the Saud regime.

Prince Mohammad bin Salman now combines in himself the roles of Deputy Crown Prince, Deputy Premier, and Defense Minister. Acknowledged as the de facto ruler of the Saudi monarchy, he has eclipsed the designated Crown Prince and Interior Minister, Prince Mohammad bin Nayef.

Known to be ambitious and bold, - considered in some quarters as rash - Prince Mohammad bin Salman launched on 25 April 2016, his 'Vision 2030' program – a policy paper and blueprint for growth - prepared by the eminent US consultancy, Mckinsey Global Initiative.

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 45–51

"Vision 2030" lays out a composite program of far-reaching structural reform designed to transform Saudi Arabia from an essentially oil-based economy into a dynamic variegated industrial economy not dependent chiefly on oil revenues.

"Vision 2030" notes that the oil price boom from 2003 to 2013 fuelled Saudi Arabia's prosperity. Saudi GDP doubled, household income rose by 75 percent, and 1.7 million jobs were created. Within a decade, despite making substantial investments in Education, Health, and Infrastructure, the Saudi regime accumulated revenue reserves equal almost to 100 percent of GDP in 2014.

Vision 2030, however, assumes that the Kingdom can no longer rely on oil revenue and public spending for growth. It assesses that the global energy market will undergo significant change by 2030, and unless drastic steps are taken to restructure the Saudi economic model, there will be a very negative and unsustainable impact on the fiscal position of the Saudi regime, and serious unemployment.

(Unrest, agitation, violence, and pressure for destabilizing the Saudi royal family's regime, are the consequences apprehended. Memories of 1979, when Juhayaan Otaybi and his squad of Ikhwan terrorists seized the Masjid al Haram and declared the Al Saud regime unIslamic, corrupt, and therefore deposed, still haunt and enervate every Saudi royal.)

Vision 2030, therefore, projects a productivity-led economic transformation designed to enable Saudi Arabia to preclude such a predicament, envisage a doubling of GDP once again, and create as many as six million new jobs by 2030 – the time the kingdom's population is expected to be 30 million.

The plan involves an investment outlay of $4 trillion, no less.

Vision 2030 identifies eight sectors: Mining and Metals, Petrochemicals, Manufacturing, Retail and Wholesale trade, Tourism and Hospitality, Healthcare, Finance, and Construction, as having the potential to generate more than 60 percent of growth needed in Saudi Arabia.

Prince Mohammad bin Salman has claimed that his Vision 2030 plan is "likely to see the Kingdom of Saudi Arabia operate without reliance on oil income by 2020". He has stressed on revamping Education, building infrastructure for the Tourism sector, and even spoken of introducing over the next five years, a US green-card type of residency system: for Arab-origin persons and Muslims.

Also in the plan is the setting up of a Public Investment Fund (PIF) of $ 2 trillion and a public offering of 5% share in the Saudi regime's golden-egg laying goose: SaudiAramco – the world's leading oil company, which by itself accounts for 10% of world oil pumped out.

Claiming Saudi Arabia has four strong inherent advantages: "Religion, Location, Arab heritage and (Arab) ability", Prince Mohammad bin Salman says: "Saudi addiction to oil has disrupted development of many other sectors".

(This is not unlike the perception being espoused in India by some experts that water-intensive sugarcane cultivation indulged in by rich and politically powerful landowners, is at the cost of intrinsically good and more worthwhile options in Agriculture and Horticulture.)

Pointedly advocating development of tourist attractions to boost Tourism Industry, the Prince makes bold to ask: "How can the Kingdom be the holiest place for Muslims and yet have no Islamic museum?"

Noting Saudi Arabia is the world's third largest purchaser of arms and military equipment, ($100 billion-worth arms were purchased from the US alone in recent years) Prince Mohammad questions why there is no arms industry in Saudi Arabia, and plans to set up a military armaments manufacturing sector.

Prince Mohammad bin Salman has also spoken of building the 'King Salman Bridge' over the Red Sea - to link Europe and Asia, and thus open construction and investment opportunities, and help move cargo worth billions of US dollars across the Red Sea.

Also planned is an increased participation of Women in the work place from 20% to 30 %.

On 7 May 2016, a major Cabinet shake-up was carried out – at Prince Mohammad bin Salman's instance, "to align portfolios and Ministers better to the plans in Vision 2030". This demonstrated his determination to compel the Saudi governance establishment to accord with and execute his plans, and was essentially an exercise in consolidating power.

The experienced octogenarian Minister for Petroleum for the last 20 years, Ali Al Naimi, was summarily ousted, - it being stated he had failed at the Doha meeting in April to secure an oil price-freeze with Iran also complying. Prince Mohammad is insistent that the Kingdom shall not freeze production till Iran does.

Al Naimi had protected oil pricing from the whims and fancies of Saudi princes.

Oil prices were quadrupled in 1973 following US support to Israel in the Israel-Egypt war.

However, since then till recently, oil pricing had been determined on basis of market trends.

(The new Petroleum Minister is Khalid Al Fateh is an executive of SaudiAramco.)

The Cabinet reshuffle also replaced the Ministers of Water, Transport, Commerce, Health, and Social Affairs – these portfolios also being renamed to conform to terms in the Vision 2030 document.

Most of the new appointees are bureaucrats and not from the royal family – leading to murmuring in the royal family.

Prince Mohammad's clout and determination have been proven. As long as his doting father the King, Salman bin Abdul Aziz is the monarch and 'Khadem Al Harmayn As Sharifayn' (Custodian of the Two Holy Mosques), the Prince can rule the roost, and wield untrammeled power across the country.

However, there is no denying that forcing top-down change is not winning him very many friends across a range of resourceful interests -- from powerful members of the expansive and immensely wealthy Al Saud family, to blinkered, antediluvian Wahhabi Islamist theologians.

The Crown Prince, Prince Mohammad bin Nayef , Interior Minister, has precious little reason to be pleased, -- the more so as Prince Mohammad bin Salman does not hesitate to deal with subjects concerning Religion, Judicial, Social affairs, and Internal Security – matters which, per tradition, stand formally allocated as being in Nayef's jurisdiction – as the Crown Prince.

The conservative Wahhabi-Saudi Arab milieu, - medieval in outlook, and prone to react violently, - is also not pleased about the Prince Mohammad's emphasis on increasing the proportion of women in workplaces, and the restrictions he has imposed circumscribing the role of the 'Committee for Propagation of Virtue and Prohibition of Vice'.

Plans for setting up Islamic Museums are also igniting anger. Wahhabism utterly abhors and denounces as being 'shirk' (polytheistic) the veneration of any object or place or entity besides Allah; only Allah is to be worshipped.

It may be recalled that in 1802-1806, Wahhabi cohorts had attacked the holy cities of Medina and Mecca, and destroyed relics and buildings associated with Prophet Mohammad's (PBUH) family – including the graves of his mother Amina, and infant son Ibrahim (over whose grave the Prophet is said to have shed copious tears), and the house of his first wife, Khadija and even the place where one of the Prophet's incisors was interned. (The front-tooth had been struck and broken off by a stone hurled during the historic Battle of Uhud.) The Wahhabis had also attacked Karbala and Najf in Iraq and destroyed holy places including mosques, tombs, and graves.

In 1925, Wahhabis had bulldozed and leveled the graveyard of the Companions of the Prophet Mohammad (PBUH) where the remains of an estimated 7000 Salafs were buried.

(NB: Just by way of citing a personal remembrance: On the Babri Masjid being attacked and subsequently demolished on 6 December 1992, a statement was prepared and issued in the name of the President of India - that had the effect of helping to allay fears of Muslims throughout the country, rally "secular and democratic forces", and enjoin the Government of India to uphold the law, protect law-abiding citizens, and act effectively against trouble-makers.

The statement had a bigger effect outside India, in that it helped subdue anger in policy-making circles in capitals of Muslim countries, and pre-empt imposition of severe penalties on India – such as a move by the Saudi regime to shut down oil supply to India.

This, at any rate, was what the Grand Mufti of Saudi Arabia pointedly mentioned to the then President in my presence in a meeting in Rashtrapati Bhavan, – that the Kingdom was on the point of issuing a condemnatory statement against the Government of India, and announcing an embargo on its oil supplies to India, -- when the news of the President's statement, and its text, happened to come to their notice. The Grand Mufti stated he had specially come to meet the President and inform this fact to the Government of India.

Several years later, when a later holder of the same office (Grand Mufti of Saudi Arabia) had come to Kabul to meet the President of the Islamic Republic of Afghanistan, he expressed severe contempt for those who reverence shrines, buildings, and objects, - and termed them "mushrikeen" (polytheists), "outside the fold of Islam", and even apostates ("murtaad") qualifying for severe Sharia punishment

The Grand Mufti then also held forth on the compelling theological justification for shifting the 'Muqa'am 'ul Ibrahim" viz. the place of Prophet Abraham – a small shrine-like structure in front of the Holy Ka'aba in the Masjid al Haraam, Mecca, -- which houses a stone bearing what is regarded as the footprint of the Prophet Abraham at the place he stood observing the Ka'aba being built.

Wahhabi ire in the Kingdom, violent fury even, need therefore hardly be a surprise, - vis-à-vis Prince Mohammad's idea of establishing museums to house and put on display Islamic relics and other 'sacred' objects for public viewing by masses of the faithful in the Kingdom.

Also noteworthy, in this connexion, of risks involved in Vision 2030, is the prognosis of financial experts about the Saudi fiscal ways and means position.

Zach Schrieber - who had predicted the oil crash two years ago when oil was priced at $100 a barrel - stated in the Sohn Investment conference last week, that: " Saudi is 'structurally insolvent' and "It has two to three years before it

hits a wall! Saudi needs oil prices above $ 100 a barrel to break even on budget, but the Kingdom is currently trapped between "huge spending commitments and cheap oil".

Saudi's war in Yemen costs $200 million per day to prosecute, i.e. $6 billion per month.

Aid to Egypt, Bahrain, Jordan, and Pakistan, and worldwide funding for Wahhabi propaganda, mosques, mullahs and madrassas, also amounts to humongous financial outgo.

Furthermore, Prince Mohammad bin Salman recently initiated a new grand military alliance involving 34 Islamic countries, ostensibly to wage war against Terrorism, Iran, ISIS, and Al Qaeda – not without substantial financial implications to the Kingdom.

(Pakistan and Bangladesh are members. Afghanistan, Central Asian Muslim States, Algeria, and Oman are not members.)

Vision 2030 thus entails cutting of subsidies to the richer classes, increased taxation, irritants to Wahhabi Arab society, and serious fiscal challenges as well.

Potential thus exists and is accumulating, for overt and covert opposition to Vision 2030 and its principal approvers and protagonists, Prince Mohammad bin Salman, and his father, King Salman bin Abdul Aziz Al Saud. The consequences cannot be presumed to be pleasant to either of them.

What eventually is the fate of the Vision 2030 program, and what transpires in Saudi Arabia's political economy, also concerns India in important ways.

Despite having diversified its sources of oil, India purchases the bulk of its oil supplies from Saudi Arabia. The number of Indians employed in the Kingdom is also significant, and their remittances are the mainstay of many families in India. India also has wide-ranging trade in engineering and manufactures under export to Saudi Arabian markets.

In any event, whether positive or negative, developments in Saudi Arabia engage India's vital national interests.

It is to be expected that, the Government of India will monitor the situation closely; simultaneously keep on building strategic oil reserves, cultivate alternative oil supply sources; and devise contingency plans ahead to deal with any eventuality.

Shrinivasrao S. Sohoni IAS (Retd.)

Shrinivasrao S. Sohoni is a Governance Specialist and Strategic Analyst. Educated at The Doon School, Dehra Dun, and St. Stephen's College, Delhi, Mr Sohoni entered the Indian Administrative Service in 1970. His over 45 years aggregate governance experience at State, Union Government, and international levels, includes key assignments in the Government of India in the Department of Cabinet Affairs, Union Cabinet Secretariat, the Ministry of Defence, the Ministry of Industry, Parliament, and in India's neighbourhood.

During a period of endemic political turbulence in the country, and four changes of government at the Centre, Mr. Sohoni was Secretary to the President of India, and Secretary-General of the Rajya Sabha, having previously served as Additional Secretary in the President's Secretariat and of the Rajya Sabha, and Secretary to the Governor of Maharashtra.

Through 2006 to 2014, Mr Sohoni served as Senior Adviser in the Office of the President of the Islamic Republic of Afghanistan, -- advising the Afghan President and mentoring the young Cabinet Secretary and senior officials in the President's Secretariat on a range of governance issues including, especially, subjects germane to Afghanistan's Constitutional, Political, and National Security perspectives.

A student of Comparative Religion, especially Islam, history of Islam, and connected trends and entities, Mr. Sohoni's current focus is on the problem of Islamic Terrorism and Extremism, and the organization of State and Civil Society approaches for purposes of Counter-Terrorism/ Extremism.

Tactical Nuclear Weapons in South Asia

Lt Gen AK Sahni (Retd)

Introduction

The nuclear tests in 1998 by India, followed in quick succession by Pakistan heralded the official nuclearisation of the subcontinent. It took another 3 to 4 years for the broad frame work of the nuclear doctrine of the two countries to be available in the public domain. This was based on the statements made by the senior political and military hierarchy of the two countries, enunciating the essential contours of the nuclear doctrine. Incase of India as a follow up, the formal doctrine was written in 2003, but there are indicators that the same does not hold true for Pakistan. The major difference in the stance of the two has been that India has stated its intention for 'No First Use', vis a vis Pakistan's intention to have it as part of its military strategy.

Since then the two countries have developed a very unique form of 'unstable- stability' in their nuclear deterrence. This has been amply proved in the subsequent crisis, where despite major provocations India exercised constraint, in its military actions. Be it the territorial violation in Kargil in 1999, or the two major Pakistan sponsored terrorist acts on the Indian Parliament in 2001 and the Mumbai carnage of 2008. There is no ambiguity that in the sub-continent, till now, nuclear weapons between India and Pakistan were taken as political *instruments*. It was also accepted by both nations that '*Nuclear Weapons'* are strategic assets and only *'instruments for deterrence'* and not for nuclear war fighting.

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 53–70

The existing status between the two countries changed on 05 Nov 2013, with the announcement of the operationalisation of the short range nuclear capable ballistic missile 'Nasr', by Pakistan. However, the debate about the introduction of Tactical Nuclear Weapons (TNWs) in South Asia was triggered much earlier when Pakistan did the first flight test of this missile on 19 April 2011. The tempo of debate heightened when Pakistan test fired the Raád cruise missile, which is capable of penetrating the 'ballistic missile defence' shields (BMDS). This was to counter the system that is under development in India. It is indisputable that *in case Pakistan* gives shape to its intention to induct TNWs in the Indian sub-continent, it will impact the existing nuclear equation and fuel

an arms race in the sub-continent. The fiercest detractors of this development were obviously India, followed by the non-proliferation lobby in the west.

There is also a need to appreciate that induction of TNWs is nearly an irreversible decision. For it is shocking that even three decades after the end of cold war, these weapons are still in the inventory of USA and Russia, the successor state of Soviet Union. Implying that once inducted TNWs would be extremely difficult to eliminate. Therefore any decision to pursue this path, further exacerbating the fragile security situation in the sub-continent, should be after concerted deliberation by Pakistan. In addition the existing internal security situation within Pakistan has its own pitfalls/ danger of these weapons falling in the hands of non-state actors.

If Pakistan decides to nuclearize 'Nasr', there are immense *challenges* that go with such a weapon system. Be it the complexities of command *and control, survivability cum protection, delegation of authority for use in the tactical battlefield or the* related *psychological pressure on Commanders. In addition the deterrence dynamics of South Asia will need to be revisited. Each of these is a subject in themselves. So in this article it shall be the endeavour to examine some of these, especially that of Pakistan's motivation to opt for 'Nasr' and to see if the existing conditions in South Asia have any similarity or parallel to 'cold war' situations, which is the raison d'etre, being propounded by Pakistan. Also issues related to technological expertise and capability to manufacture weaponised* SRBMs (Nasr) in the overall construct. It shall however not be in the preview of this article to address the various nuances of deterrence, India's options and related issues in detail as they are subjects on their own. The spectrum of impact is indeed vast and at this stage would like to reiterate that complexities to employ TNWs as an instrument of war fighting is far easier said than done.

It is also highlighted that in this article the impact of TNWs on the existing nuclear calculus will be discussed within the framework of India – Pakistan and

not take into consideration that India's other neighbour China is a nuclear state and enjoys an asymmetric advantage over it in the economic – military sphere. Undoubtedly India's nuclear policy will always have to be conscious of China in case of a review or further qualification of the nuclear doctrine.

Pakistan's Stated Position

Nasr SRBM is another example of the strong cooperation cum support nexus existing between Pakistan and China, in the area of nuclear proliferation. The missile system is undoubtedly based on *Chinese design cum technology and is* an adaption of the of the A–100 Chinese MLRS, mounted on a high mobility vehicle, carrying four 'ready-to-fire' ballistic missiles of about 300 mm diameter. The weapon system can carry a nuclear warhead which is assessed to be plutonium based, with a stated yield varying from 0.5 to 5 kiloton. Nasr's mobility enhances its survivability as it gives it the flexibility to avoid *counter-targeting*.

Initially, commentators representing the Strategic Plans Division (SPD) contended that the Nasr was merely a short range weapon and the effects sought from this missile were strategic in nature. Also, it would be significantly adding to the existing deterrence capability. This was aptly clear in the prompt but ambiguous press release of the Inter Services Public Relation (ISPR) Directorate of Pakistan after the test firing of Nasr: *Quote "Pakistan today successfully conducted the 1st flight test of the newly developed Short Range, Surface to Surface, Multi Tube Ballistic Missile, Hatf-IX (NASR). The missile has been developed to add deterrence value to Pakistan's Strategic Weapons Development programme, at shorter ranges. This SRBM with a range of 60 km carries nuclear warheads of appropriate yield with high accuracy and shoot and scoot attributes." Unquote*

This perception was reinforced as the flight test was only witnessed by senior officers from the strategic forces, scientists and engineers of strategic organisations. The DG *SPD* Lieutenant General (Retired) Khalid Ahmed Kidwai, on this occasion said that the test was a very important milestone in *consolidating Pakistan's strategic deterrence capability at all levels of the threat spectrum.* He said that in the hierarchy of military operations, the Nasr now provides Pakistan with short-range missile capability in addition to the medium & long-range ballistic missiles and cruise missiles in its inventory.

The implication of the above statement along with other official iterations at various forums indicated that this weapon system was an asset of Pakistan Army's Strategic Force Command (ASFC). The implication of Nasr going to

ASFC was that Pakistan would exercise *assertive control* over SRBMs and thus *preclude* the likelihood of *pre-delegation during peace* time.

The first official statement with respect to use of nuclear weapons for war fighting was made by Pakistan's Foreign Secretary, Mr Aizaz Chaudhury, in Oct 2015, prior to the visit of the Prime Minister of Pakistan to USA. He said during a press interview:

"Pakistan has built an infrastructure near border areas to launch a quickest response to Indian Aggression---Usage of such low yield nuclear weapons would make it difficult for India to launch a war against Pakistan"

Thereafter, Mr Kidwai, ex DG SPD and advisor to Pakistan NCA, at a press conference at the *Carnegie International Peace Conference* in 2015, clarified unequivocally Pakistan's intention that the short range missile was to be an element of its 'full spectrum deterrence doctrine'. He stated that the development of short range missiles is based on Pakistan's unwritten but consistent security policy that relies on nuclear deterrence to make up for shortfalls in conventional asymmetry and rapidly shrinking defence budget. This posture would nullify India's 'Cold Start Strategy' and will permit Pakistan to maintain its posture of 'minimum credible deterrence', within its limited financial means.

Examinations of the above iterations confirm that the initial statements by Pakistan's officials did not indicate that the short range weapon system was meant for war fighting. Because as an accepted norm, all nuclear weapons in South Asia, irrespective of ranges or yields, were weapons for deterrence. But the subsequent volte face to state that these missiles would be part of their 'full spectrum deterrence' and a counter to India's 'Cold Start Doctrine' in a conventional conflict, indicated the intention to use 'Nasr' as part of its military strategy, in the tactical battle field. Thus, confirming the apprehension that Pakistan is viewing its mix of short and long range missiles, including cruise missiles as weapons for war fighting and for want of a better word, the TNW became a real threat.

Defining TNWs?

Before proceeding further, it is important to understand what are TNWs? As that will influence the response that would be required and assist in examining

their impact on the existing state of deterrence. With no other precedence other than the 'cold war', the debate and analysis of this genre of weapon is generally based on the experience and events that unfolded during that period in Europe, between the erstwhile Soviet and NATO bloc, with the battle lines defined in the then divided Germany. But an understanding contextual to South Asia will be necessary for suitable iterations by India, to meet this emerging threat in the sub-continent.

Tactical Nuclear Weapons based on the cold war rationale, are weapons with lesser yields or shorter ranges as compared to strategic weapons meant for counter value and counter force targets. During the 'cold war' these weapons were deployed in forward locations for use on the European battlefield, to deter or counter a Soviet invasion. To rival these, the Soviets developed a whole range of their own TNWs. Some of these weapons as stated earlier are still deployed in Europe and form part of the non-deployed arsenals of US and Russian nuclear forces**.**

Therefore, it would be correct to infer that the differentiation between *strategic and tactical nuclear weapons is a function of range, yield, and/ or the methodology of employment*. It needs to be highlighted that though the two cold war adversaries agreed on range based definition for *strategic nuclear delivery vehicles* in the 1970s, during the Strategic Arms Limitation Accords and later in 1991 for START 1, they were either not willing or were unable to come to a common definition for tactical nuclear weapons. In context of the *realities of that era*, the *difference between tactical and strategic nuclear weapons was also rooted in capability of these weapon systems to attack American or Soviet/Russian mainland and the extended deterrence commitment of USA towards its NATO allies*. *Range, and not the yield, was thus the primary factor* in deciding what constitutes a tactical or strategic nuclear weapon in the cold war parlance.

The ambivalence with respect to defining the TNWs still remains, as is evident from the Russian and US glossary of military terms. Russia presently categorise these nuclear munitions as *non-strategic, operational and tactical*. *Non-strategic nuclear weapon* includes operational and tactical weapons with ranges less than 5000 Kms. *Operational nuclear weapons* are designed to engage targets up to a depth of 500 kms and *tactical weapons* upto 300 kms. This categorisation is not sacrosanct and is dependent on the importance of the mission. In case of the US the weapons are categorised as 'non – strategic' and 'theatre nuclear forces'. *Non-strategic nuclear forces* are those that are employed for mission accomplishment in a theatre of operations and the *'theatre nuclear forces'* are designed for localised

military missions'[1]. Therefore, it seems that the yardstick for categorising nuclear weapons, other than strategic seems to be more *a function of their employment*, wherein the range and yield are a subset. Therefore, TNWs in context of the two major nuclear powers can be defined as '*short range- low yield nuclear weapons*' with a maximum range of 500 kms and yields varying from 0.4 to 150 kilotons. These nuclear weapons are for employment on the battle field for counter-force targeting and could be surface or air-launched.

TNW include a wide range of weapons such as *gravity bombs, short range missiles, artillery shells, land/sea mines, depth charges, torpedoes and atomic demolitions* which can be used to render defiles/ chokepoints unusable. TNW may have special features to enhance its impact in the battlefield like *variable yields or neutron bombs* for maximising ionising radiation exposure while minimising blast effects. TNW may also include earth penetrating bombs designed to target caves or deep-underground bunkers. BLU118B Massive Ordnance Air Blast bomb (MOAB) was used by US forces in Afghanistan to flush out the Taliban/ Al Qaeda from Tora Bora caves in 2001. On 31 January 2013, the Israelis used earth penetrating weapons to destroy the alleged Syrian chemical and biological weapons facility at Jimraya, near Damascus. *It needs to be emphasised that the type and technical specifications of the future TNWs, if manufactured by Pakistan, would be influenced by their desired rationale for induction to the tactical space. Therefore, if the aim is to defeat Indian army's mechanised spearheads in the Indo – Pakistan context, the employment considerations would far outweigh the criteria's of range and yield, while developing the weapon systems.*

Translating these definitional nuances of TNWs to South Asia, the following inferences can be drawn. Unlike the East-West proxy battlegrounds in Europe, which were geographically detached from the American and Soviet/Russian mainland, *Pakistan and India have contiguous borders.* Several cities and towns along the border and the Line of Control (LOC) in Kashmir would be within Nasr's range. Therefore, *all nuclear weapons in South Asia should be considered strategic,* because they would have *strategic effect in terms of psychological impact, damage, and number of casualties, radiation fallout*, as well as the administrative and logistical challenges that are caused, long after the weapons have been used.

Apropos, if one endeavours to define these short range weapons in context of South Asia, then we should classify these as *'battlefield nuclear weapons'*,

1 NATO/Russia Glossary of Nuclear Terms and definitions, http://www.nato.int/docu/glossary/eng-nuclear/index.htm

with ranges of 50 to 150 km, with the weapon yield varying from 5 to 10 KT. The restricted yield is in consonance with the desire to minimise collateral damage, as these are primarily to be employed for *counter-force targeting in high density population areas*.

Another factor often overlooked in categorisation of a nuclear weapon is the question about who exercises authority over the use of these weapons. Whereas, the decision to use a nuclear weapon is vested in the supreme political leadership, sometimes the control is delegated to very junior officers like submarine captains, fighter pilots and field commanders in the tactical space. At that stage of conflict wherein the authority is delegated to the lower rungs of command for employment, the political and the military high command would actually be out of the decision making loop. Such like weapons can therefore be classified as 'tactical nuclear weapons'.

Pakistan's Motivation

The Kargil conflict of 1999 (Op Vijay) and the year long standoff between the Indian and Pakistan military, post the terrorist strike on the Indian Parliament in 2001 (Op Prakaram), led to introspection of their respective military doctrines. In case of India it reaffirmed that there is space for conventional conflict under the existing nuclear overhang in the sub-continent. And the geo- economic asymmetry in favour of India, demands a more robust and offensive doctrine. In addition it was obvious to India that being nuclear states, any confrontation between the neighbours will see international pressure being bought upon India for restraint. Therefore, the delay in mobilization of its offensive forces, witnessed during the preceding stand offs, required to be redressed on priority. India also realized that Pakistan's 'brinkmanship', is a reality in almost all cases of Indo – Pak stand offs. And in the present case be conscious of identifying the underlying aim of Pakistan to undertake this testing of the SRBM Nasr. Is it the preliminary stage of development of short range battle field weapon system for nuclear war fighting? Or is it to create a perception that imposes restraint in the mind of the Indian political and military leadership.

The lessons learnt resulted in India enunciating and adopting the '*Cold Start Strategy*', that later matured to the current '*Pro Active Strategy*'. It also resulted in operational modulations like *forward placements of war waging resources, relocation of formations, including certain Headquarters and technological upgrades. These actions were with the aim to hone the combat edge, while reducing the mobilisation time*. This strategy also looked at exploiting *the intrinsic weakness*

of the defensive deployment of Pakistan, caused due to the commitment of its combat power along the Af – Pak Border.

As a consequence of *India's doctrinal shift***,** Pakistan carried out a series of analytical studies, culminating in the '*Azm e Nau*' series of discussions/ exercises. Based on their findings, Pakistan adopted a doctrinal modulation called the 'New Concept of War Fighting' (NCWF). This entailed raising and relocation of combat assets, development cum forward placements of resources, technological upgrade and capacity building and in all likelihood the decision to pursue the path of developing TNWs, to further curtail the space for conventional conflict. This is because Pakistan's security establishment regards all kinds of nuclear weapons as guarantors against a growing existential threat.

It would be fair to state that there would have been a combination of reasons for Pakistan to have selected this course of action. Some of the major contributory factors would have been, *firstly, India's new doctrine for its western borders.* The speed and tempo envisaged in India's 'proactive strategy' would see its mechanized forces breaching the operational depth of the Pakistan within the first operational cycle, rendering its defensive strategy redundant. *Secondly, realisation* has dawned on the Pakistan politico – military hierarchy that there is a *growing asymmetry in the combat force ratios* of the two countries, in the conventional spectrum. This is likely to only increase with its own commitment of combat resources on the Afghanistan border and growing internal strife resulting in increased commitment for CT tasks and India's economic growth. Simultaneously there is a perceptible upgrade in terms of technology and capacity in India's combat power, including induction of lethal cum accurate long range vectors. *Thirdly* it feels that the existing *balance in deterrence is being marginalized* due to India's development of a 'ballistic missile defense' and therefore its interest in cruise missiles and TNWs as a counter. *Lastly*, Pakistan's perception that the strategic equilibrium has changed due to the Indo – US civil nuclear deal and exemption accorded to India by the 'Nuclear Suppliers Group'. Therefore, in all probability the Pakistan military which has a decisive voice in the country's nuclear strategy would have been instrumental in exercising this option, disregarding the negative impact on deterrence.

It would be fair to summarize simplistically that *the need for TNWs is rooted in the* ***'Deterrence Gap'*** *below the strategic threshold. It was perceived by the super powers during the cold war in a different context and now by Pakistan. Stephan Cohen* has aptly stated in his book '*The Idea of Pakistan*' that *Pakistan's military exposure to western nuclear strategizing, has resulted in current nuclear planning and*

*doctrine that "very much resembles American thinking with its acceptance of 'First Use' and tactical use of nuclear weapons, against on rushing conventional forces***."**

The Cold War Parallel

Pakistan has been justifying its actions for introducing TNWs because of near similar conditions in the sub-continent to what existed then on the European battle front, during the cold war[2]. How far it is true is not so relevant, for arguments can be tailored to find equivalence. AVM Kapil Kak has put it across very succinctly that Pakistan's justification of parallel to conditions of the cold war era is "bourbon like flawed advocacy not founded on lessons from that period". The two are widely apart not merely in time, but in transformation of nuclear weapons from being tools of war fighting to political instruments. But it is more important to see through the cold war lens to gain greater clarity in understanding the complex challenges related to the various facets associated with TNWs.

It was in the 1950s that TNWs were first *introduced in Europe.* The spectrum of nuclear arsenal over time included *nuclear mines, artillery shells for the 203mm and 155mm guns, short range ballistic missiles (SRBMs), ADMs and aircraft delivered munitions.* These were *deployed* by the United States and its NATO allies to *counter the* shortage of manpower and conventional weapons against the offensively configured Soviet Motor Rifle (MR) Divisions. Also, the stringent financial cutbacks on the US military, including its downsizing, initiated in the Eisenhower era were contributory reasons for their development and deployment. In response the Soviet bloc also introduced their own arsenal of TNWs. Over a period of time the Soviet Union also viewed their TNWs and conventional capabilities, as integrated components of their offensive doctrine. Logical follow up led to formulation of relevant doctrines and operational plans, including *integrating nuclear and conventional fire planning.* Another reason for this step by NATO was that as the Soviet Union achieved sophistication in their strategic nuclear delivery vehicles, it became difficult for the United States to strengthen nuclear deterrence only through strategic nuclear weapons.

For NATO, a combination of conventional and nuclear weapons, including

2 Feroz Khan, "Challenges to Nuclear Stability in South Asia," The Non Proliferation Review 10,No1,Spring 2003,p 65

TNWs, were weaved into its strategy of '*flexible response*', adopted by John F. Kennedy in 1961. *Flexible response* empowered the United States to respond to aggression across the spectrum of warfare and fill the gap between conventional conflicts to an all-out nuclear war anchored on its policy of 'massive retaliation'. It also enabled USA to meet its obligations of *'extended deterrence'* for its allies.

The war fighting strategy in Europe then was conceptualized at three levels. The first phase was conventional war in the European continent, contingent to failure of deterrence and outbreak of hostilities. This was to be followed by 'tactical nuclear battle' before it evolved into a full scale nuclear war. In the Cold War scenario, TNWs were meant for use on the battlefield, as opposed to strategic nuclear weapons which were designed for counter value or counter force targets against big cities or large military formations, whose destruction could severely retard the enemy's warfighting / deterrence capabilities.

Conventional wisdom dictated that the TNW should become obsolete after the demise of the Cold War. However, these still form part of the post-Cold War arsenals of the US and Russian nuclear forces. According to 2015 estimates the US still possesses 500 TNW, while the Russian Federation has 2000. Therefore, the concern that even if bilateral relations improve, once inducted, the TNWs are there to stay. It will have a long term impact on regional security and demands an extensive debate, prior to the final decision.

Apropos, the rationale for Pakistan to contemplate induction of TNWs to meet 'force asymmetry' and defeat large scale high intensity conventional offensive by India, with parallels to cold war, *appears implausible*. This is because NATO never intended to block Soviet invasions with TNWs, but it was to be employed in the escalatory continuum of conflict in the European battle space. Another reason was to leverage TNWs for political signalling and minimise collateral fallout in the eventuality of conflict.

Also, the force ratios between India and Pakistan will remain dynamic, due to ongoing efforts by India to enhance military capabilities on its northern borders with China. Such measures would further widen the conventional gap. For Pakistan to keep pace with this growing asymmetry may not be possible and force it to place greater reliance on TNWs. This is a 'Catch 22' situation, which will further aggravate the fragile security balance in the sub-continent. It will negatively impact and lower the nuclear threshold, thereby defeat the complete rationale of deterrence. There is a truism that Pakistan needs to keep in mind based on the experience of the cold war, that TNWs cannot fill the gap for conventional imbalance.

Operationalisation Challenges

The major area of concern for employment of nuclear weapons, on the battle field, is the *Command and Control* during hot war. This may be *defined* as "*an arrangement of facilities, personnel, procedures and means of information acquisition, processing, dissemination and decision making used by National Command Authorities and military commanders in planning, directing and controlling military operations*".[3]

'*Command*' of nuclear weapons is concerned with the conduct of military operations to achieve political objectives. In the realm of employment of nuclear weapons, '*control*' becomes a question of technology and wiring and of delegation cum devolution of authority in crisis.[4] The primary pre requisite for '*effective control*' is the prevention of accidental or inadvertent war. This delegation could lead to premature and flawed escalation irrespective of the checks and balance in vogue. The level and means of surveillance, communication linkages and maturity of commanders, many a time averted a nuclear war when the world was at its cusp. Examples abound from the era of the Cuban crisis and cold war. In case of Pakistan the status of support structures and resources coupled with the radicalisation of a large percentage of its tactical commanders with flawed Islamic ideology is indeed a matter of concern. However, the balance has to be maintained for too much of control mechanism can lead to delay in employment and defeat the very purpose of this weapon system on the inventory.

Effective command and control demands a robust, secure and fool proof *communication linkage* between the decision makers and the delivery system. In addition, a reliable and credible, accident free decision cum delivery system, for battle field nuclear weapons is anchored upon the availability of a *credible intelligence* capability and survivable *surveillance and reconnaissance* means. The latter is important for the decision maker due to shorter time of flight of these missiles/ munitions from launch to target.

The complexity of this function of command can be summed up by the three intricate dilemmas, which are quite self-explanatory. Firstly, the short

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3 Shaun R Gregory, Nuclear Command and Control in NATO, London Macmillan Press 1985,pp 3-4

4 Stephen J Cimbala, Rethinking Nuclear Strategy(Wilmington, Delaware: Scholarly Resources Inc.,1988), pp217-231

ranges of these weapon systems, like the US 'Lance missile' during the cold war, requires their deployment closer to the battle field and commanders have to contend with the dilemma of ***'use them or lose them'***. Correspondingly, there is greater pressure on escalation. Also, there is the dilemma of ***'always - never'*** as the system is required to do two very contradictory functions. It must always deliver when it is so required, and must never fail in peace time by permitting unauthorised use. Lastly, is the ***'request – release'*** challenge for the commanders. This existed for the commanders during the cold war and shall exist for the Pakistan if it goes all the way to give shape to its desire for inducting battle field nuclear weapons in South Asia.

Another very important facet of employment of nuclear weapons is the issue of "positive and negative control measures". Positive control concerns the authorisation of nuclear operations, which can only be given authorised decision makers. On the other hand negative control seeks to prevent accidental or unauthorised use of nuclear weapons including possible theft by non-state actors.[5] The "positive control "is exercised through mechanical/ electronic devices referred as "Permissive Action Link (PAL).[6] The "negative control" to obviate unauthorised use, prior to the release from NCA is maintained by the 'two man'/'three man' rule or through PALs. The other critical issue is the security and protection of these assets from both, targeting by adversary and from non-state actors. The situation is exacerbated when there is domestic instability in the country, as in Pakistan.

Technological Evaluation

Examination of the technological capacity is a function of the *availability of fissile material* and the *technical expertise to manufacture* miniaturised warheads for these short range low yield weapons. The type of fissile material and the size of warhead will influence the design and the expertise required for its

5 Gurmeet Kanwal, Command and Control in the context of TNWs, Ch 6,pp 119,Pakistan's Tactical Nuclear Weapons. "Stephen Twigge and Len Scott," Learning to Love the bomb: The Command and control of the British Nuclear Forces, 1953 - 1964", The Journal of Strategic Studies , Vol 22,No 1, March 1999."

6 Pakistan seems to have improved the safety and security of their nuclear weapons, by implementing the 'two-man rule' while installing Permissive Action Links (PALS), and ensuring that warheads are de-mated from their delivery systems during peace time.

manufacture. The relevance of inducting TNWs would be established if the number of devices required is manageable. In case the numbers are large then the deployment considerations, security of the assets, requirement of fissile material and time lines for manufacturing a viable number would need to be considered

Let us first see the number of TNWs required to achieve its stated objective to destroy an Indian offensive modulated on multiple thrusts. Two physicists at Princeton University in 2010 carried out this exercise. To destroy by blast alone approximately 50% of the 1000 tanks and armoured fighting vehicles on one of the eight thrusts planned in the 'Pro Active Strategy' by India, will require 100 nuclear weapons of 15 Kilotons each. In case of thermal radiation to kill the crews, the numbers would be 80 with a similar yield[7]. Therefore, to destroy 8 x thrusts across approximately 2000 kms of border, the numbers will be extremely large. Another study came up with an absurd figure of 436 nuclear weapons to stop one Indian Armoured Division. These numbers would increase or decrease depending on the dispersion within the columns and the yield of the weapon. Therefore with such large numbers the requirement of fissile material and the security of these assets thereafter, make the military utility of these weapons questionable.

On the aspect of miniaturisation, the technical challenge and prowess will depend on the type of fissile material being used. The warheads could use 'Highly Enriched Uranium' (HEU) or Plutonium. In case of the HEU the design could be based on the 1950s vintage W 33 *gun type fission device.* In this case the amount of fissile material will decide the yield of the weapon and there are indicators that testing for the same has already been done by Pakistan. This assessment is based on the available reports about *Pakistan's cold and hot tests' of nuclear weapons carried out reportedly since March 1983 (24 sub critical cold tests carried out between 1983 & 1990 related to weapon design) and the tests on 28 and 30 May 1998.* Three, out of the six tests on 28 and the one on 30 May 1998**,** (a total of four tests) were reported to be of *sub-kiloton yield*. Therefore the key issue is whether Pakistan has the expertise to meet the extremely high standards of precision engineering, reliability and accuracy, required for its manufacture and follow on maintenance.

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7 A H Nayyar and Zia Mian,"The limited military utility of Pakistan's Battlefield Use of Nuclear weapons in response to large scale Indian conventional attacks", Pakistan security research unit, Brief No 61, November 11,2010,pp1-10

In case of Plutonium as the fissile material for the warhead, there is a requirement to compress it for miniaturisation. Therefore, any Plutonium weapon design can only be operationalised after testing of a suitable plutonium based implosion device. Pakistan claims that it has tested this aspect in one of the four tests done in 1998. But this is questioned and not corroborated by the international scientific community. Also, the requirement of plutonium could be extremely large as its requirement does not reduce in proportion to the yield. However, Chinese technical expertise and support may empower Pakistan to manufacture weapons with yield up to 0.4 kt. This could be a probability in view of the statement reported by Jang newspaper in 2009 of Pakistan's President, Mr Musharraf, to US officials that Pakistan has developed "among the world's smartest (miniaturised) tactical nuclear devices.

Another aspect with respect to the design of TNW, are the uncorroborated claims of Pakistan with respect to the 1998 tests, which if true gives Pakistan the *option for making all genres of nuclear weapons,* including *the low-yield warheads. Testing of a boosted fission device that uses a mix of uranium, plutonium and tritium* can to an extent reduce the requirement of fissile material for similar yield devices.

The next critical issue is the availability and requirement of fissile material. In case of HEU the requirement of fissile material for weapon yields beyond 20 kt increases substantially. This is the material also required for its strategic arsenal, so how much will be available for the numerically large requirement of TNWs is a big question mark. In case of Plutonium, the operationalisation of the 4 x unguarded Khushab reactors constructed by China, provide the linkage for Pakistan's quest to develop Plutonium based TNWs. It is assessed that these may give Pakistan up to 450 Kg by 2020[8].

Apropos , there is a possibility that with Chinese support and the unguarded nuclear facilities that are in Pakistan , it may be able to give shape to its intention of manufacturing TNWs, if it so decides in the near future. However, it will have to be established that it is not part of Pakistan's brinkmanship.

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8 Ah Nayyar,Zia Amin and R Rajaram,"Exploring Uranium Resource Constraintson Fissile MaterialProduction in Pakistan,"Science and Global Securit, Vol 17, No. 2-3.2009,pp. 77-108

Critical Implications for Pakistan

There is no doubt that giving shape to this intention of Pakistan has innumerable ponderables and some of the major issues are summarised. Firstly, the induction of SRBMs by Pakistan seems to be on its conviction that this is the only means to defeat the conventional asymmetry / India's current doctrine and *reduce space for a full-fledged conventional* conflict from taking place in the region. Secondly, it believes that it will strengthen its '*minimum credible nuclear deterrence',* with simultaneous actions to address the existing shortfalls in its 'capability' and 'credibility', and *effective 'signalling' to* convey its will-to-use. *Thirdly*, the use of this short range weapon system would facilitate in filling the existing void of a weapon to demonstrate its resolve to use nuclear weapons, once India crosses its stated Red lines. *Fourthly,* it is questionable if TNWs will increase deterrence and obviate chances of limited conflict, but yes the availability of TNWs will give Pakistan the means to indulge in Brinkmanship and exploit the card of irrationality to strengthen cum reduce the threshold of nuclear deterrence**.** *Fifthly*, the security of TNWs which will have to be stored in dispersed locations in proximity of its national borders will be extremely worrisome, especially due to the unstable internal security environment within the country. Also as the control will have to be delegated for employment of the TNW to field commanders, the probability of premature or accidental release is an area of concern. *Sixthly*, it will have complicated its bilateral relations with the other neighbours, *Iran and* Saudi Arabia. *Lastly*, *a state with fragile internal security resilience like Pakistan with TNWs shall weaken the impact on deterrence* and correspondingly *strategic stability* in South Asia.

India's Response

There are conflicting views on what should be India's response in case Pakistan does finally induct TNWs. Strategic analysts for and against have their justifications. It is my considered opinion that developing own TNWs as a response by India is a big 'No', primarily as it will be against India's considered policy that enunciates that strategic nuclear weapons are political instruments and meant for deterrence. Due to the catastrophic effect of a nuclear explosion, there should be no space for a new 'genre' of nuclear weapons in the Indian lexicon. India should continue to insist that a "nuke is a nuke". A changed stance by India will further embolden Pakistan to believe that there is space for *'Limited Nuclear Exchange'* in the sub- continent. Already the present nuclear stalemate is being exploited by *Pakistan to continue its proxy war against India*

and the lowering of nuclear threshold with the introduction of TNWs may lead to Pakistan increasing the intensity of the ongoing proxy war and also consider enlarging its footprint from the valley in J&K, to other parts of the country. Development of TNWs would violate India's principle of 'credible minimum deterrence posture', which is not anchored on *numbers*, but on ensuring survivability of its *minimum required nuclear arsenal.* It would also entail a relook at the present policy of NFU and *'massive retaliation'. It is an accepted fact that India's present response strategy is stabilising and any tinkering will have negative ramifications.*

India therefore cannot be a silent spectator to the unfolding events in Pakistan, but needs to study the impact of introduction of battlefield nuclear weapons. It would require making the existing system of

'handling cum operationalisation' of the strategic nuclear weapons more robust and address the existing voids / shortfalls in the ISR / early warning systems and the command and control elements. The present structures of the National Command Authority and the doctrine need to be optimally stitched and harmonised. The NFU demands fool proof measures for protection and survivability of our strategic nuclear assets. There is a need for synergising the application of our conventional combat resources and the strategic assets. Undoubtedly there is an essential requirement to raise the long awaited post of CDS/ Permanent Chairman Chief of Staff Committee to be the single point military authority responsible for national security. The existing *dissonance on some issues within the MoD and MHA needs to be addressed.*

The Signalling and C4 ISR are not as robust as they should be. Thus, the 'credibility' of our response is at times questioned, and this will be under greater scrutiny in case of induction of TNWs in South Asia. There is a need for India to develop 'Launch on Warning (LOW)' and 'Launch under Attack (LUA)' capabilities, backed by an effective BMD system. This will add another dimension to the existing capabilities.

Signalling at the ground level needs to complement the efforts at the politico – diplomatic level. Therefore, at the level of the field force, actions have to be publicised that convey India's intent to wage conventional conflict, irrespective of the threat of TNWs. This is possible by subtle publicity, of reorganised inbuilt structures for NBC within the armed forces and acquisition of personal and collective protection cum decontamination kits/ elements. Theatre and operational plans should look at denying the adversary space for employing TNWs, as it would cause extensive collateral damage to its own people.

Conclusion

The follow on activities after the testing of 'Nasr' in Pakistan needs to be critically placed under the scanner to confirm the future direction and intent of Pakistan. There is a need to be able to read between the lines to ascertain if the testing and subsequent debate on TNWs was part of posturing or preliminary to actualisation of induction of TNWs. Pakistan is a past master at 'brinkmanship' and this action could be part of the greater design to impose caution on the politico- military hierarchy of India. There is also a need to monitor the transfer of technology related to miniaturisation of nuclear war heads being pursued in China and North Korea. They have and continue to support the nefarious designs of Pakistan.

In the end I conclude by stating that the lowering of nuclear threshold coupled with the security of TNWs in a highly volatile internally agitated environment is a recipe for disaster. Non state actors and nuclear terrorism are a reality in today's world and more so in this region. These are issues of universal concern and Pakistan should tread with caution to an act that will fuel proliferation. Let not the 'frankistien' created devour the hand that made it.

Lt Gen Arun Kumar Sahni, PVSM, AVSM, SM, VSM (Retd)

The General Officer was commissioned into the Regiment of Artillery on 13 Jun 1976 and retired as General Officer Commanding – in – Chief, South Western Command, Indian Army on 31 Jan 2016. He has been a high achiever throughout his service and done all the prestigious career courses including being a recipient of the prestigious 'Sword of Honour' and the President's Gold Medal on commissioning. He has been an Instructor at various Military Schools of Instruction, attended the Gunnery Staff Course with the British army at UK, was Assistant Military Attache in Russia and has been intimately involved with force structuring, op preparedness and modernization of the Indian Army. The officer is a known for his academic excellence and oratory skills. He is incisive with his strategic insight and understanding of internal and external security issues including the emerging international dynamics.

GAGAN: An Indian Satellite-Based Augmentation System (SBAS) for Civil Aviation and its Applications

Dr S.V. Kibe

Abstract

The Indian Space Research Organisation and Airports Authority of India have implemented a Satellite Based Augmentation System (SBAS) called GAGAN as part of the satellite based Communication, Navigation, Surveillance (CNS) / Air Traffic Management (ATM) plan for Civil Aviation. The objective of GAGAN (GPS Aided GEO Augmented Navigation) is to establish an SBAS for safety-of-life civil aviation applications over the Indian Air-Space.

For satellite based navigation two core constellations – Global Positioning System (GPS) of the United States and GLONASS of the Russian Federation are available. The position accuracies achievable with these core constellations are not good enough for precision approach and landing requirements of Civil Aviation. These constellations need to be augmented. Three types of augmentation systems are possible - Ground Based Augmentation System (GBAS), Aircraft Based Augmentation Systems (ABAS) and Space Based Augmentation System (SBAS).

GAGAN has been certified by the Indian Director General of Civil Aviation (DGCA) initially for en-route operations (RNP 0.1) on December 30,2013 and subsequently on April 21,2015 for precision approach services (APV 1.0) standard of the ICAO. Since May 19, 2015 APV 1 certified signals are being broadcast over the Indian Air Space and can be received on a smart phone as well. GAGAN was

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 71–83

dedicated to the Nation on July 13, 2015. GAGAN is only the third system in the world after WAAS of Us and EGNOS of Europe.

GAGAN provides three services –Position, Navigation and Time. It provides benefits beyond aviation to many other segments such as in railways for anti-collision, accurate and speedier land surveys over large areas, geodesy, intelligent transportation, security agencies, telecom industry, intelligent transportation, maritime use, precision agriculture etc. BrahMos – the Indian ramjet supersonic cruise missile uses the new navigation system consisting of an Indian chip called G3OM (GPS, GLONASS, GAGAN on a Module) providing high accuracy targeting without using any seeker.

This paper describes the three segments of GAGAN – User Segment, Space Segment and Ground Segment.

GAGAN Satellite-Based Augmentation Systems for Civil Aviation

Introduction

International Civil Aviation Organisation (ICAO) Member States have endorsed Global Satellite Navigation System (GNSS) as a primary future system for aviation. GNSS provides world-wide coverage for seamless aircraft navigation. Satellite transmission along with ground enhancement will enable the users to perform on-board position determination for en-route, terminal, non-precision and precision approaches.

The Airports Authority of India (AAI) have implemented an indigenous satellite based regional GPS augmentation system also known as Space based Augmentation System (SBAS) as part of the Satellite based Communication,Navigation, urveillance (CNS) / Air Traffic Management (ATM) plan for civil aviation. Towards this end, a National Plan for Satellite based Navigation System has been prepared. The Indian SBAS called GAGAN (GPS And Geo Augmented Navigation) System is implemented jointly by the Indian Space Research Organisation (ISRO) and AAI.

The present ATM systems in the Asia Pacific region suffer short comings which include

(a) Lack of surveillance facilities over large areas of region which require relief from congestion.
(b) Air route availability constraints by point source navigation aids resulting in choke points.
(c) Dissimilar ATS procedures and separation standards causing Flight Information Region (FIR) boundary changes to flight profiles.
(d) Un-coordinated provision of present CNS system resulting in duplication of resources and services.

(e) Lack of appropriate parallel ATS route structures to relieve route congestion and,
(f) Poor quality communication facilities and language difficulties.

The first SBAS system was developed by the United States using two INMARSAT-III GEO Navigation payloads (POR & AOR-W) and is called the Wide Area Augmentation System (WAAS). European Geostationary Navigation Overlay System (EGNOS) is being implemented by the European Space Agency since 1996 and is expected to be operational in the year 2004-2005. EGNOS uses the other two INMARSAT-III Navigation payloads (IOR & AOR-E). The MTSAT Satellite Augmentation System (MSAS) is being implemented by the Civil Aviation Bureau, Ministry of Land, Infrastructure and Transport, Government of Japan and is expected to be operational by 2004-2005. All evolving SBASs must comply with Standards And Recommended Practices (SARPs) specified by ICAO to provide seamless navigation to civilian aircraft across the globe. The SBAS implementation over the Indian Airspace has bridged the gap between the evolving EGNOS and MSAS system.

A mechanism has been evolved where the Indian system is a part of an evolving Global Navigation Satellite System (GNSS) consisting of the core constellations and the SBASs. The US WAAS system in the far West, the European EGNOS, Indian GAGAN and Japanese MSAS complete a global coverage for civilian aircraft. *(See Fig.1)*

The Need and types of Augmentation

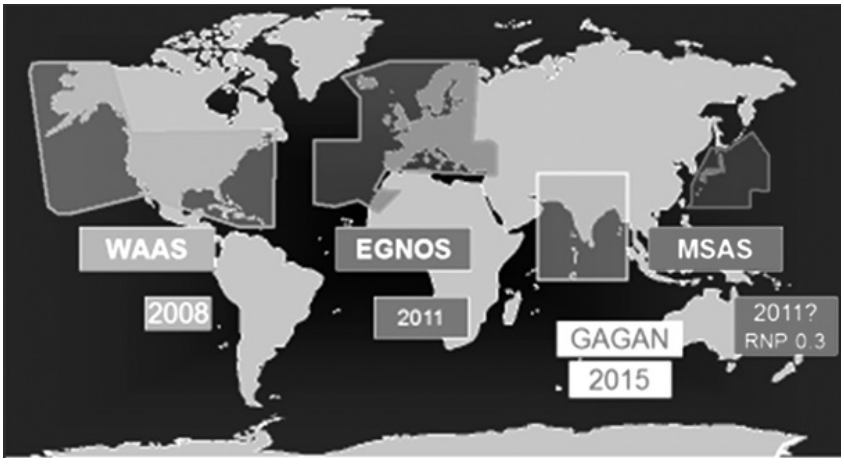


Fig. 1. GPS Augmentation systems in the World (For APV - 1.0 capability) Korea, Egypt, Canada and Africa may go for SBAS

At present, there are two core constellations which provide satellite-based navigation in the world – The Global Positioning System (GPS) of the United States and GLObal NAvigation Satellite System (GLONASS) of the Russian Federation. These core constellations provide position accuracies of the order of 30 meters, Circular Error Probable (CEP) anywhere on the surface of the earth through inexpensive hand-held receivers. Both these systems operate in the L-band. The accuracy available through these core constellations is not adequate for precision approach and landing requirements in civil aviation.

The core constellations can be augmented in three ways - Aircraft Based Augmentation System (ABAS) augments and/or integrates the information obtained from GNSS elements with information available on-board the aircraft in order to ensure operation according to the values specified in ICAO SARPs.

Ground Based Augmentation System (GBAS) consists of augmenting the core constellation through differential GPS elements implemented close to an airport and transmitting the corrections to the aircraft through a suitable data link.

Space Based Augmentation System (SBAS) refers to having GEO satellite based GPS compatible navigation payloads over a region supported by the necessary ground segment and uplink earth stations. The User Differential Range Errors (UDREs), improved iono-tropo grid models and improved GPS ephemeris are transmitted to the GEO based navigation payload which retransmits these to modified GPS user receiver also called GNSS Receivers.

Civil aviation requirements for satellite-based navigation are specified in the ICAO Standards And Recommended Practices (SARPs) which specifies the Signal-in-Space Performance requirements for civil aviation in terms of accuracy, integrity, time to alert, continuity and availability as follows:

- Accuracy (Horizontal): .....16 m
- Accuracy (Vertical): .....6 m
- Integrity: 1-2x10-7
- Time to Alert: .....6 secs.
- Continuity: 1-8x10-6
- Availability: .....0.99 – 0.99999

Integrity

Integrity is a measure of trust that can be placed in the correctness of the information supplied by the total system. Integrity includes the ability of a system to provide timely and valid warnings to the users (alerts).

Time to Alert:

The maximum allowable time elapsed from the onset of the navigation system being out of tolerance until the equipment enunciates the alert.

Continuity

Continuity of a system is the capability of the system to perform its function without unscheduled interruptions during the intended operation.

Availability

Availability of GNSS is characterized by the portion of time the system is to be used for navigation during which reliable navigation information is presented to the crew, auto pilot or other system managing the flight of the aircraft.

SBAS Concept

The Wide Area Differential GPS (WADGPS) also known as SBAS concept is illustrated in *Fig. 2*. There are five major elements in any SBAS:

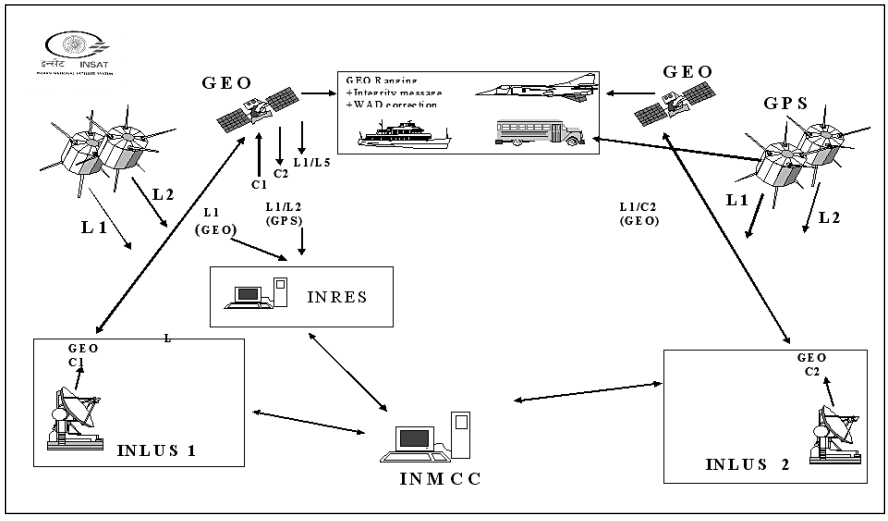


Fig. 2. WADGPS Ground Segment Concept

(i) Reference stations (RESs)
(ii) Mission Control Centre (MCC)
(iii) Land Uplink Station (LUS)
(iv) The GEO Payload &
(v) User GNSS receivers

Indian Reference Stations (INRESs)

INRESs collect measurement data and broadcast messages from all the GPS and GEO satellites in view and forward it to the Indian Mission Control Centre (INMCC). As per the present planning, 15 INRESs are be located at the following places in India:

- Ahmedabad
- Bangalore
- Bhubaneshwar
- Calcutta
- Dibrugarh
- Gaya
- Goa
- Guwahati
- Jaisalmer
- Jammu
- Nagpur
- New Delhi
- Porbunder
- Port Blair
- Trivandrum

Indian Mission Control Centre (INMCC)

The chief functions of the INMCC are

- Network Management (communication and computer)
- Integrity monitoring
- Iono-Tropo Model delay estimation
- Wide area corrections – separation of errors
- Orbit determination
- Command generation

The INMCC shall consist of a main frame computer and a host of secondary computers connected to a network. The communication interfaces of the INMCC with other ground segment elements is shown in *Fig.3.* INMCC is collocated with the INLUS at Bangalore. Yet another INMCC is being established at New Delhi.

Indian Navigation Land Uplink Station (INLUS)

INLUS communicates with the Indian Nav. Payload. This earth station receives messages (which contain UDREs and Iono-tropo grid models) from the INRESs through the INMCC, format these messages and transmit them

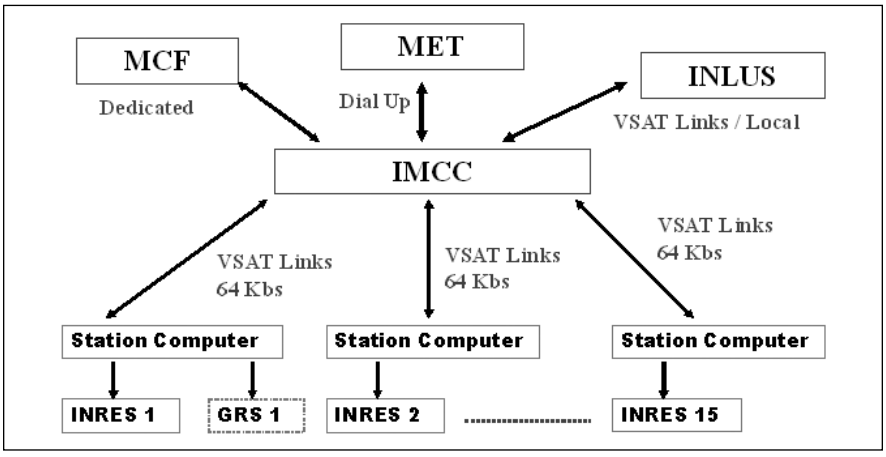


Fig. 3. Communication Interfaces

to the GEO satellite navigation payload for broadcast to users. The INLUS also provides GEO Ranging information and corrections to the GEO satellite clocks. Message formats and timing are as per the ICAO SARPs.

A configuration of the Indian Navigation Land Uplink Station is shown in Fig.4.

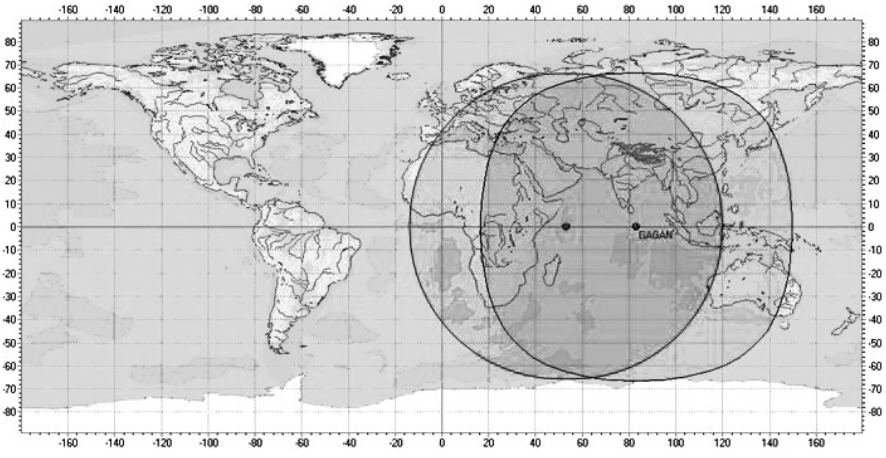


Fig. 4. Gagan payload coverage from 82 and 55 deg.E

Navigation Payload

It is planned to fly a Navigation payload compatible with GPS L1 frequency and L5 frequency on an Indian satellite to be positioned in the Indian Ocean Region between the orbital arc 48 deg. E to 100 deg.E longitude during the Phase-1. The salient characteristics of the payload are:

- L1 D/L EIRP (Max.) = ...33.5 dBW
- L5 EIRP (Max.) = ...33.0 dBW
- Receive G/T= .....-5 dB/oK
- Power Amplifier =.....40 Watts
- Coverage=.....Global
- Mass = ...50 Kg
- Power =.....230 W

The functions of the Nav. Payload are:

- to relay Geostationary overlay signal compatible with GPS L1 frequency for use by modified GPS receivers.
- to provide a CxC path for ranging by INRESs with an uplink from the INLUS.

The EIRP can be adjusted within a suitable range through on-board attenuator settings. The frequency plan is shown in *Figs. 5.*

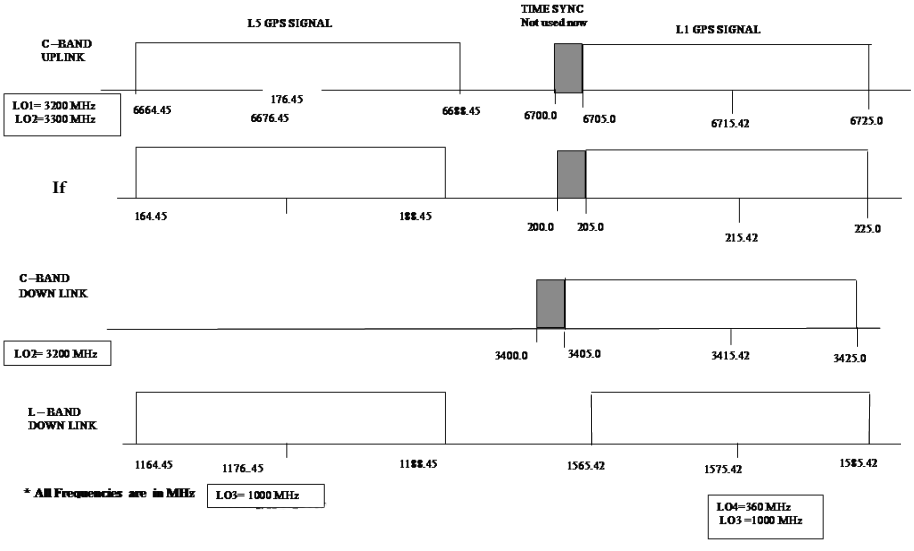


Fig. 5. Frequency plan for the satnav load

Several antenna configu-rations for L-band are under study. Some of the candidate antennae are

- Prime focus reflector
- Helix array
- Patch array

The first payload was operational in the year 2010. The L1/L5 frequency payload footprint with three operational GAGAN payloads is shown in *Fig. 6*

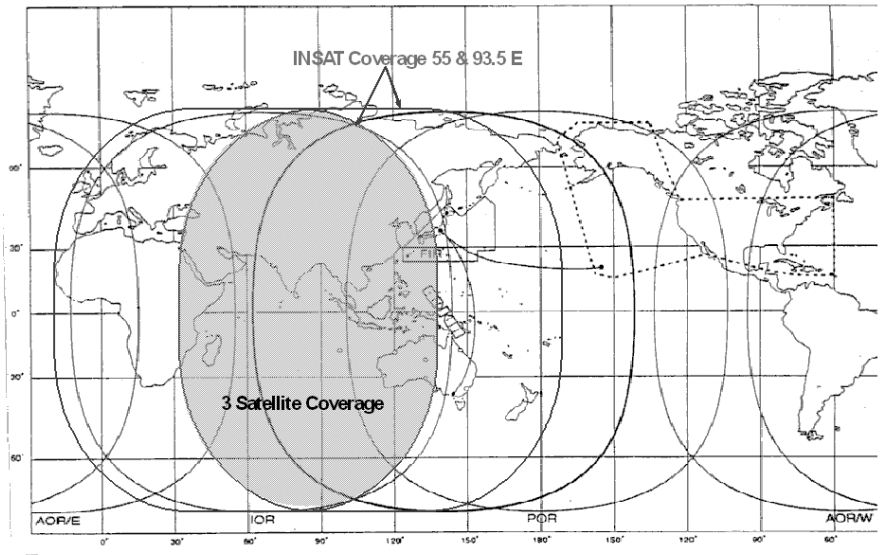


Fig. 6

The GAGAN System

Full Operational Capability (FOC) for GAGAN was reached through an initial

Technology Demonstration System (TDS). The objective of the Technology Demonstration System (TDS) is to develop indigenous capability in SBAS implementation.

Under the TDS, the Indian Space Research Organisation (ISRO) is established the necessary ground and space segment for demonstration of SBAS functioning over a limited airspace initially.

The ground segment configuration for the TDS phase was as follows:

(i) Up to 8 Indian Reference Stations (INRESs) at widely separated geographical area in India.

(ii) An INdian Master Control Centre (INMCC) located at Bangalore.
(iii) An Indian Navigation Land Uplink Station (INLUS) collocated with the INMCC
(iv) One Navigation Payload in the Indian Ocean Region (IOR) between the orbital locations 48 deg. E to 100 deg.E.

GAGAN was certified for RNP 0.1 by the Director General of Civil Aviation(DGCA) on December 30,2013, and for APV 1.0 on April 13,2015, GAGAN payloads are carried on three Indian GSO satellites- GSAT-8 (55 dg.E), GSAT-10 (82 deg.E) and GSAT-15 (93.5 deg.E)

Impact of Ionospheric Tropospheric multi-path, ephemeris and clock related errors

The ionosphere delays the L-band signals and introduces unpredictable range errors. The ionospheric conditions in the low latitude regions are more difficult to measure and model.

The ephemeris error in the data downlinked through the GPS L1 frequency to ordinary GPS receivers is in the vicinity of about 7 – 8 meters. This translates to an equivalent position error. In SBAS a better ephemeris model (through UDREs) is transmitted to the Geo-Stationary satellite which enables a modified GPS receiver to improve the ionospheric and ephemeris related errors resulting in better position accuracies. Clock errors are offset through accurate measurements made at INRESs since this is a one dimensional error.

Ephemeris

It is well known that the signal multi-path at the reference stations caused by satellite signal reflection and defraction from overhead and nearby objects degrades ranging measurements. Adequate care will be taken to have antennae and receivers at the INRESs to reduce multi-path errors.

Iono-Tropo Modelling

(i) Iono-Tropo modelling and scintillation studies in the L-band will be carried out over the entire Indian Airspace as an integral part in the TDS Phase 1.

The following strategy has been adopted to develop suitable grid based ionospheric model over the Indian region.

(a) About 20 total electron content (TEC) receivers shall be located at the Centre of the 25 deg x 5 deg. ionospheric grid points (IGP) over the Indian region as shown in *Fig.7.*

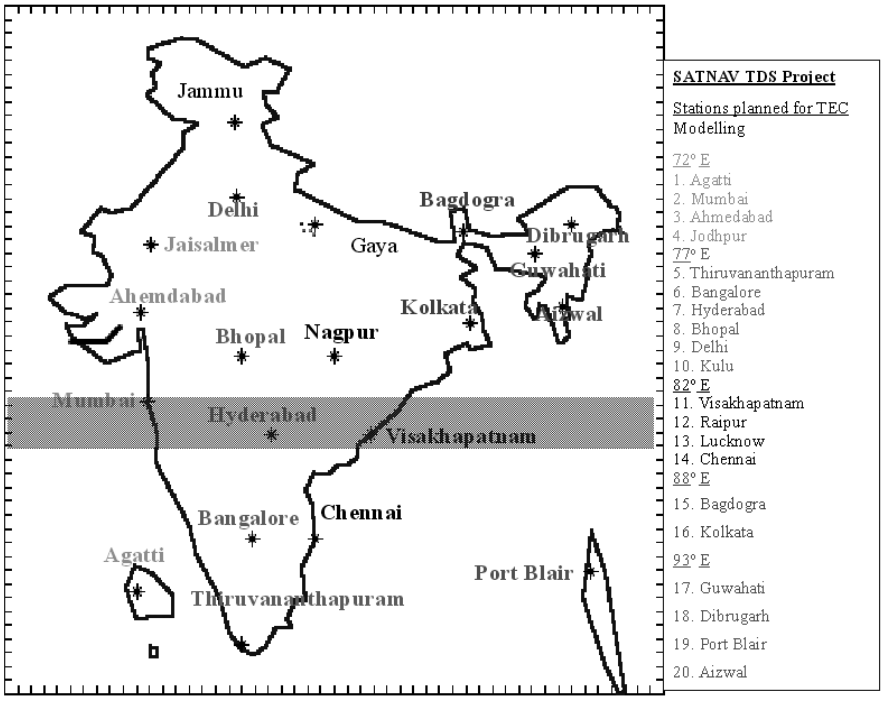


Fig. 7 Planned TEC Stations

(b) The data from these receivers shall be logged into a personal computer and the logged data shall be delivered to all academic and scientific institutions on which contracts are placed to carryout the necessary studies.

(c) All receivers and PCs shall have an uninterruptible power supply (UPS) and necessary housing at all the 20 sites. The instrumentation at all the sites shall be identical. A suitable Ionospheric Scintillation and TEC monitor receiver equipment which is best suited for these studies shall be deployed at all the sites.

International Coordination

Advanced Publication Information (API) for the Indian Nav. Payloads has been filed with the International Telecommunications Union (ITU).

During the IEP and FOP, international assistance would be sought for the definition of inter-operability for the Indian SBAS, system validation, testing and certification.

User Segment

GAGAN receivers are being manufactured in India with indigenous technology. GAGAN signals are available on smartphones. Many L1 and L5 chipsets are marketed in India at a very low cost.

Other SBASs

Three SBASs have reached the APV 1.0 or better certification – US WAAS, European EGNOS and Indian GAGAN. Japanese MSAS has only reached RNP 0.3 level for route navigation.

Applications

Indian GAGAN is being used in many areas other than civil aviation for PNT services. Some of the areas are:
(1)Railways for Anti-Collision,
(2)Precision Agriculture,
(3)Land surveys with WADGPS rather than Differential GPS
(4) Intelligent Transportation System
(5)Location Based Services (LBS)
(6)Security applications
(7)Cruise missiles etc.

On July 8,2014, Brahmos Aerospace conducted the 44th test launch of the missile from the ITR to a target designated 290 km away. It was the first test of the missile in supersonic dive mode against a hidden target using a new Indian s/w algorithm and multiple Satellite Navigation systems for guidance, without the usual homing system. The new navigation system uses an Indian chip called G3OM

(GPS, GLONASS, GAGAN on a Module). The system weighs around 17 grams and gives accuracy below 5 meters. The system can be used in tandem with Inertial Navigation system(INS) to provide high-accuracy targeting without using any seeker.

The applications of GAGAN in India are limited only by our imagination!

Dr Suresh V. Kibe

Dr. Suresh V. Kibe has over 44 years' experience in Satellite Communication and Satellite Navigation He led the GNSS team in the Indian Space Research Organisation (ISRO) from 1993 to 2010.

He was responsible for establishing the Indian Satellite based Augmentation System GAGAN which has been certified by the Indian Director General Civil Aviation (DGCA) for APV-1 standard of the International Civil Aviation Organisation (ICAO). He chaired the Signals Committee of the Indian Regional Navigation Satellite System (IRNSS) from 2006 to 2009.

He was invited by the DG,ESA as an International Fellow in GNSS at ESTEC in 1996. He was invited by the Administrator NASA to be an International Member of the PNT Advisory board for GPS from 2007 – 2011. He chaired the second meeting of the International Committee on GNSS (ICG) held in Bangalore in Sept.2007

He has filed an International patent on Use of Low Density Parity Check Convolutional codes (LDPCCC) FEC in GNSS data structure on 27.08.10.

He retired from Govt. service in early 2011 and since then has been a technical consultant in Satellite Communication and GNSS to EC, Korea etc.

He has several technical publications in IEEE Trans. Communication, IEEE Journal of Solid State Circuits, IEEE Trans in Instrumentation etc. He has contributed extensively to the ITU=R WP-4C and UN OOSA publications on GNSS.

Progress of China's Aviation Industry

Air Vice Marshal MM Bahadur (Retd)

Introduction

The progress made by the Chinese aviation industry has been closely scrutinized by analysts for the speed at which technology has been absorbed and put into products. While some hyperbole is expected in their domestic media, the overall thrust has been to create an impression that the Chinese aviation industry is fast reducing the gap that exists with American and Western products. While there is some truth in the prevalent view, all is not 'above board' in the claims being made. It is time to take stock of some major Chinese aviation programmes and comment on their progress, since widely accepted views tend to affect assessments and decisions taken by military planners and political decision makers. Noted historian Paul Kennedy, while analyzing conflict in the past five centuries, has brought out clearly in his *magnum opus* 'The rise and fall of the Great Powers" that when nations rise and develop economically, they have to go offshore for raw materials; this brings them in dispute with other rising powers and has been the cause of conflict down the ages. This historic fact, almost a truism, is a given from which India and China cannot escape as they advance on their respective paths.

While the glossary of Chinese aviation products is big, this essay would analyse some of the *more commonly known, but significant,* aircraft development programmes of the Chinese aviation industry, including transport aircraft and helicopters; the implications for India would also be analysed at the end.

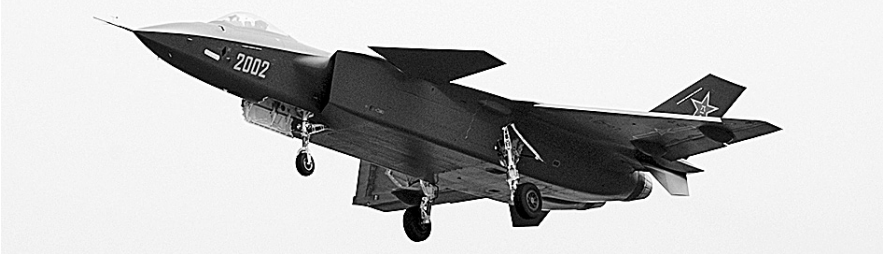
ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 85–96

Fighter Aircraft

J-20 Stealth Fighter

Designed as a fifth generation aircraft to match the F-22 of the US, the J-20 of the Chengdu Aerospace Corporation has been developed purely for the Peoples Liberation Army Air Force (PLAAF) and not offered for export. The aircraft flight test programme commenced in January 2011 and the first Low Rate of Initial Production (LRIP) aircraft was seen on the tarmac in December 2015. This is in line with the five years taken by the F-22 and F-35 also, from first prototype to production model. However, in case of China this feat is very creditable considering the fact that the US has had past experience with stealth aircraft manufacturing but the J-20 is the first for the Chinese.



J-20 Stealth Fighter

The J-20 has the classic characteristics of a stealth aircraft with recessed engines, angular deflection plates, a deep set cockpit, an internal weapons bay and a skin texture with radar absorbent material that supposedly gives it a low Radar Cross Section (RCS). Equipped with an Active Electronically Steered Array (AESA) radar, the aircraft would carry long range and infra red guided missiles, besides air to ground smart munitions. The Chinese press has reported that the J-20 would be equipped with the Electro Optical Distributed Aperture System (EODAS). The EODAS is a revolutionary system that gives a pilot 360 degrees *spherical* situational awareness, protection and targeting capability and is supposed to be operational only on the American F-35. If the Chinese have actually mastered this technology and are positioning it in the J-20 then it would indeed make the aircraft very potent. The technology is available only with the US and more reports are needed to come to a firm conclusion on this aspect in case of the Chinese. There is another intriguing aspect to the J-20 flight testing**;** there are no photographs showing release of weapons or armament firing by any of the J- 20 prototypes, except for some which show the

weapon bay open and internal bomb carriage capability being demonstrated. While this is insufficient to draw any negative conclusions about the success of the firing trials till now, it is certainly a point for conjecture regarding an aircraft whose programme has reportedly entered the LRIP phase.

Another interesting point that has been raised is about the operational role assigned to the J- 20 - - whether it is a pure fighter for an air superiority task or is it a ground attack machine too. Additionally, *no* two J-20 have been seen in the air together. At 67 feet length, it is perhaps the longest contemporary fighter whose role could well be a high speed transit through American radar defences to take out high value targets like the Airborne Warning and Control System (AWACS) aircraft or a flight refueling tanker- - not an easy task to execute as such high value assets generally operate away from the borders and are always well protected with fighter escorts. The J-20 is expected to attain Initial Operational Clearance (IOC) by 2017-18 and Final Op Clearance (FOC) by 2020.[1] Then, why is China buying the Su- 35 from Russia? The conjecture is that the 24 x Su-35s being purchased are to cover the interim period till enough J- 20 are in PLAAF Squadron service**;** however, another view is that the procurement is being done to get an insight into high-end jet engine technology that would enable Chinese engines to give true fifth generation status with super-cruise capability (supersonic flight without the use of afterburners) to the J-20. The absence of reliable indigenous high end fighter jet engines is an area that China is acutely aware of and is reportedly sinking billions into jet power plant technology research.

J-31 Stealth Fighter

The Shenyang J-31 was unveiled on 11 November 2014, while US President Barack Obama was in Beijing for the APEC summit**;** the political connotations cannot be overlooked because the Chinese never miss a chance to signal a message. Incidentally, a similar upstaging was done by the Chinese on 12 January 2011 when the J-20 was unveiled even as US Defence Secretary Robert Gates was meeting Chinese President Hu Jintao.[2] In both cases the

1 "J-20 Black Eagle [Black Silk?] (Jianjiji-20 Fighter aircraft 20) / F-20," Available at http://www.globalsecurity.org/military/world/china/j-20.htm, Accessed May 20, 2016.

2 Jeremy Page and Julian E. Barnes, "China shows its Growing Might," *The Wall Street Journal,* Available at http://online.wsj.com/articles/SB10001424052748704428004576075042571461586, Accessed May 20, 2016.

signal meant to be conveyed by the Chinese was clear – "we too have arrived." However, the reality is slightly different than this.

J-31 Stealth Fighter

The J-31 heavily resembles the American F-35, leading to the charge that China had stolen the blue prints from Lockheed Martin, an assertion they vociferously deny.[3] The aircraft is a private development of the Shenyang Corporation, with no orders at present from the PLAAF, unlike the Chengdu developed J- 20. The J-20 is much larger and would have better capability, implying that it would be costlier. Hence, it is conjectured that Shenyang Corporation took advantage of this aspect to tap into the aspirations of developing nations to equip their air forces with a cheap but a modern aviation asset.[4] It is reported that Pakistan has shown interest in buying thirty to forty J-31s.[5] The Chinese have hinted that if a country decides to buy the J- 31, it would help it in its endeavour to set up a defence industry. This is an allurement being offered to play on nationalistic sentiments and make the J-31 programme a commercial success. The fact is that even the so-called joint China-Pak JF-17 fighter programme was conceptualised and

3 China's Cyber-Theft Jet Fighter, *The Washington Post,* November 12, 2014, Available at http://online.wsj.com/articles/chinas-cyber-theft-jet-fighter-1415838777 , Accessed May 21, 2016.

4 Bradley Perrett, Robert Hewson, Reuben Johnson and Bill Sweetman , "AVIC promotes J-31 as an Export Fighter, November 19, 2012, http://aviationweek.com/awin/avic-promotes-j-31-export-fighter Accessed June 01, 2016.

5 Farhan Bokhari, "Pakistani official confirms Su-35 talks," Available at http://www.janes.com/article/54532/pakistani-official-confirms-su-35-talks Accessed May 15, 2016.

designed by Chengdu company as the FC-1 and is basically a 'know how' type of a technology transfer to Pakistan and not a true 'know why' situation; the PLAAF has not bought the JF-17 (just like the J-31).

In its attempt to sell the J-31, the Chinese debuted it at the Dubai air show in 2015.[6] It was claimed that the first production FC-31 (export version) model would fly in 2019 and the aircraft would get its Initial Operational Clearance in 2022 with the Final Operational Clearance expected in late 2025.[7] Interestingly, Jane's Defence says that, "…achieving the first flight (of the export version FC-31) in 2019 is also contingent upon securing a "well-funded" customer." The J-31 has 10 hard points (four internal, six external) and has a payload capability of 8 tonnes (2 tonnes internal and 6 tonnes external). The possible weapon fits include an internal gun, PL-9 air-to-air missiles (AAMs), SD- 10A (improved) AAMs, small-diameter bombs, and air-to-surface missiles. There is now speculation that the Shenyang Corporation is making a carrier based naval version of the J-31.[8] A computer generated image of the supposed design has been carried by a Chinese website.[9] Till the advent of the F- 35B, the US Marine Corps model, all naval aviation was confined to conventional radar reflecting aircraft – the air defences on the shore, and more importantly on warships, were accordingly equipped with conventional radars. The operationalisation of the F-35B and C models by the Americans and J 31B by the Chinese (if the news about its development is true) will revolutionise naval aviation capability in terms of its offensive potential and at the same time place a great burden on the modification of the naval air defence structure. However, there is many a hurdle to be crossed by China, the biggest one being of an adequate power plant on the J-31 for carrier operations.

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6 Gareth Jennings, "Dubai Airshow 2015 : AVIC sets out plans for FC-31 export fighter," November 10, 2015, Available at http://www.janes.com/article/55873/dubai-airshow-2015-avic-sets-out-plans-for-fc-31-export-fighter Accessed May 17, 2016.

7 Greg Waldron, "Dubai: Customer sought for AVIC's new stealth fighter," Available at https://www.flightglobal.com/news/articles/dubai-customer-sought-for-avics-new-stealth-fighte-418777/ Accessed May 31, 2016.

8 "China reveals updated J-31 Gyrfalcon stealth fighter," September 29, 2015, Available at http://nextbigfuture.com/2015/09/china-reveals-updated-j-31-gyrfalcon.html Accessed May 30, 2016.

9 http://www.thjunshi.com/jbdt/2016/1/27/71672.shtml

Long Range Stealth Bomber

Long Range Stealth Bomber

The H-6K is the only 'strategic' bomber that China presently possesses. Read in conjunction with the 2015 China National Security Review, which clearly states that one of the major tasks of its armed forces is to safeguard Chinese overseas interests, the sudden deluge of articles in the Chinese press on the long range bomber starts taking some meaning. This has gained further currency with the US announcing its own plans to start the LRS-B programme (Long Range Strike Bomber)[10] and the Russians having re-opened their Tu- 16 Blackjack production line. H-18 and H-20 are reportedly the designations given to the Chinese products – the former a theatre bomber and the latter a flying wing design. While a Chinese LRSB is still many years away, it is a programme that strategists need to keep a close eye on. The entry of a Long Range Stealth Bomber in PLAAF or PLAN inventory will have a major impact on the force structuring and balance of military power in the region.

Y-20 Transport Aircraft

The impetus to attain self-sufficiency in transport aircraft production was given a push in China when the US withdrew from the co-production of MD-90 McDonnell Douglas aircraft project in late 1990s.[11] The Chinese then developed the Y-20 as a hybrid between the Russian Il-76 and the American

10 Bill Gertz, "Stealth Bomber Race Underway," November 04, 2015, Available at http://www.washingtontimes.com/news/2015/nov/4/inside-the-ring-stealth-bomber-race-underway/?page=all Accessed May 28, 2016.

11 http://en.wikipedia.org/wiki/McDonnell_Douglas_MD-90 Also see Jeff Gerth and David E. Sanger, "Arcraft deal with China is Questioned," October 30, 1996, *The New York Times,* Available at http://www.nytimes.com/1996/10/30/world/aircraft-deal-with-chinese-is-questioned.html Accessed June 01, 2016.

Y-20 Transport Aircraft

C-17. The Y-20 fuselage is broader than the Il-76 permitting it to transport bulker military loads,[12] which would be a significant advantage for the Chinese armed forces. There have been indications in the western analyses that the flight testing of the Y-20 heavy lifter is in the final stages[13] but what is for a fact is that the aircraft, as and when cleared for operational service, would debut with the Russian D- 30KP2 engines. Once these are replaced with the indigenous WS-20 high bypass fourteen tonne thrust engines, considerable amount of flight testing would again be required to clear the aircraft for operational use. Thus, there is still some time before one would see the Y-20 on the flight line with four indigenous WS-20 engines and an enhanced payload capability that almost matches the C-17. It can be taken for granted that, in future, the Y-20 would be the platform used for indigenous flight refueling tankers and the mounts for AWACS.

Jane's has reported that a PLA National Defense University study in July 2014 showed that the Chinese military needs at least 10 transport regiments and as many as 400 x Y-20s to conduct operations in Asia.[14] While this could be true, an intangible spin off would be in civil aircraft manufacturing. Once that happens, the civil aviation manufacturing sector, that is already producing

12 "Y-20 Kunpeng / Y-XX Grand Canal," Available at http://www.globalsecurity.org/military/world/china/y-xx.htm Accessed May 25, 2016.

13 Richard D. Fisher Jr, "China's Y-20 aircraft may enter Service in 2016," March 01, 2016, Available at http://www.janes.com/article/58397/china-s-y-20-transport-aircraft-may-enter-service-in-2016 Accessed June 01, 2016.

14 Richard D. Fisher and James Hardy, "China's NDU Recommends 400-strong Y-20 Fleet," IHS Jane's Defence Weekly, 28 July 2014 quoted in Brett Witthoeff, "A view from the West: Reef of Discontent in the South China Sea," Available at http://www.navalreview.ca/wp-content/uploads/public/vol10num3/vol10num3art7.pdf Accessed June 07, 2016.

aircraft, would get a boost and start challenging the monopoly of the two Western aircraft majors viz., Boeing and Airbus, and the Russians in sales to the developing world. Due the large numbers of heavy transport aircraft required by the Chinese military, the future of the Y- 20 is secure**;** in fact, once successful with a Chinese engine, it would begin sales to its traditional customers like Pakistan and in South America, when they start looking for newer heavy aircraft.

Civil Aircraft

Civil Aircraft

China is the biggest civil aviation market in the world and is likely to be so in the coming decades, especially since it is moving from an export oriented economy to one that would be more dependent on domestic consumption. This would imply opening up of the hitherto restricted hinterland to developers implying creation of more road, rail and air infrastructure. Sensing this, the Chinese government has given a great impetus to design and develop civil passenger carrying aircraft and challenge the monopoly of Boeing and Airbus. This is in consonance with the sustained thrust to obtain certification from Western agencies so that Chinese aircraft can be marketed to their operators for operations in the air space in Europe and the Americas. Some notable progress has been made by the Chinese aviation industry, as covered subsequently.

Y-12 Sale to the US

Y-12

More than 20 countries have bought the seventeen seat Y-12 aircraft which is used for sightseeing and light cargo ferry**;** a major breakthrough was achieved with its sale to a company in the US. It is known that the clearances from the American Federal Aviation Authority (FAA) are hard to come by due to the high standards demanded and the costs involved in getting an aircraft certified. If these small commuter aircraft prove a success in terms of cost of operation and general acceptability, then the huge American aviation market could see a flooding of relatively cheaper FAA certified Chinese aircraft. Recently, 15 of these machines have been ordered for the Russian market too.[15] These breakthroughs are a big shot in the arm for the Chinese civil aviation industry as it goes about trying to test and productionise a single aisle one hundred and fifty eight seat passenger aircraft (C-919) and challenge the monopoly of Western manufacturers Boeing and Airbus.

New Aircraft Manufacturing Plants of Western Aircraft Companies.

Airbus is creating an aircraft finishing plant at Tianjin for its A-330 wide bodied passenger aircraft with Boeing also planning to follow suit.[16] and will start

15 China aircraft maker to export 15 Y-12E planes," Available at http://en.xinfinance.com/html/Industries/Manufacturing/2015/174648.shtml Accessed June 06, 2016.

16 Wang Jiamei, "Airbus starts work on plant for A330," Available at http://www.globaltimes.cn/content/971550.shtml Accessed June 06, 2016.

delivering two aircraft per month from 2017 onwards to customers *worldwide*. This is the second such factory after the A-320 facility that came up in 2008 and indicates a shrewd move by China to transit from single aisle A-320s to wide body A-330. It needs to be remembered that the C-919 single aisle Chinese passenger aircraft is undergoing testing now[17] In either case, it would be China which stands to gain engine technology that it desperately needs.

Fourth Generation Stealth Helicopter.

AVIC, the Aviation Industry Corporation of China, has confirmed that it is developing a fourth generation stealth helicopter.[18] Fielding of a hypersonic weapon by China is still a decade plus away; however, India needs to plan for its capability to pierce an ABM shield of a country, which India is developing. Additionally, strategic planning demands the acquisition of hypersonic technology indigenously to ensure timely deterrence stability in the relationship.

Summation

China's aviation industry has taken impressive strides along as part of the general 'rise' of China. However, in war, it is the combination of a machine and the war fighter behind it that tilts the progress in one's favour. The Chinese are acutely aware that their military personnel lack actual war experience**;** they are also aware that their war fighters are grounded in the Soviet/Russian way of prosecuting war, which is quite centralised and tightly controlled by higher formations. The disadvantages that this accrues in aerospace warfare is particularly acute and PLAAF is attempting to learn from western tactics by exercising with West-oriented air forces like Pakistan, Turkey, Philippines and Indonesia. This would take time, but the trend in China's thought process is clearly discernible. There is a time window of finite proportion for China's adversaries to plan and catch up. India is acutely aware of this even as its political leadership grapples with new geo-political realities in the Indo-Pacific.

Indian defence minister Mr Manohar Parrikar's visited China in April 2016

17 "Sino-Russian helicopter engine to be made in Russia," Available at http://www.therussophile.org/sino-russian-heavy-lift-helicopters-engine-to-be-made-in-russia.html/ Accessed June 03, 2016

18 Franz Stephan Gady, "Will this Chinese weapon be able to sink an Aircraft Carrier?" Available at http://thediplomat.com/2015/06/will-this-chinese-weapon-be-able-to-sink-an-aircraft-carrier/ ACCESSED June 01, 2016.

and generated great inquisitiveness, as it ought to. Besides the various high level meetings with his counterpart his visit to Chengdu, the headquarters of the newly created Western Theatre, was significant by it being scheduled in the Defence Minister's programme. While a bit of 'psy war' angle can be discerned, it is surprising that his stay neither included a visit to any aviation factory nor was any modern aircraft like J- 20 or J-31 shown to him. Is this diffidence a pointer to under confidence would be difficult to guess, but it certainly was strange, especially since the Chinese are past masters at signaling. This, however, should not take away from the fact that the progress made by the Chinese aviation industry has been impressive and something that Indian planners need to monitor closely and balance out before a large asymmetry in technology develops. The Gulf War and other conflicts in the past two decades have shown that technological asymmetry can be fatal and can be wished away only at one's peril.

Air Vice Marshal Manmohan Bahadur

Air Vice Marshal Manmohan Bahadur, retired from the Indian Air Force after 36 years of distinguished service. He is an Experimental Test Pilot from the French Test Pilots School, a graduate of the Air Command and Staff College, USA and a post graduate in Defence and Strategic Studies from Madras University. He has commanded a frontline Helicopter Unit and two Flying Bases, was the Contingent Cdr of the first IAF United Nations Mission in Sudan and has been Head of Training (Air) at Defence Services Staff College, Wellington. As Asst Chief of Air Staff, the author was the operational head of Transport and Helicopter Operations of the Indian Air Force for two and a half years. His last assignment was as Asst Chief of Integrated Defence Staff in-charge of perspective planning and force structure of the Services. He writes for leading national newspapers and professional journals and his core interests concern Air Power and Strategic Affairs. AVM Bahadur is currently a Distinguished Fellow at the Centre for Air Power Studies, New Delhi.

A Perspective on India's International Defence Cooperation

Maj Gen Shishir Mahajan (Retd)

"Defence Cooperation has now become an important component in the conduct of a country's foreign policy and security affairs encompassing all activities undertaken by the Defence Forces to avoid hostilities, build and maintain trust, and make significant contribution towards conflict prevention and resolution."

ANNUAL REPORT 2006–2007, MoD, INDIA

Introduction

Recent conduct of one of the biggest-ever multi-nation field training exercise hosted by India 'Force 18' at Pune and Exercise ' Red Flag ' at Alaska in USA highlights the growing importance being accorded to defence cooperation by the Indian Armed Forces. Six-day long Exercise Force 18, conducted under the framework of the ASEAN defence ministers' meetings plus, was themed around 'Humanitarian mine action' and 'peacekeeping operations' The exercise has added substance to India's Act East Policy. India's soft as well as hard power capabilities were projected well in the exercise as India possesses one of the strongest armed Forces in the world. Another important aspect was that despite its ongoing maritime dispute in the South China Sea and the East China Sea, China agreed to be a part of the drill, as did the US and Russia, despite several differences. It is clear that China did not want to be left out of such a region-wide military exercise.

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 97–110

Exercise 'Red Flag" aimed to provide ample opportunity for exchange of ideas relating to concept of operations in a dynamic warfare environment. This multinational air exercise which lasted for 15 days was a complex and advanced network centric operation, the toughest test for flying machines and men. This is the second time that India participated in such an exercise after 2008. This was the most complex aerial exercise involving forces from India and the US that also saw Aerial Early Warning aircraft from NATO forces in action.

While India has undertaken defence cooperation activities since the late sixties, they were restricted in nature and mainly consisted of attending training courses at the defence institutions, visits of senior officers and exchange of defence Attaches. It is only in the twenty first century that the defence cooperation really picked up momentum. It is the Indo US defence cooperation which created an institutionalised structure and spearheaded a host of activities from 2002 onwards.

This article is aimed at analysing the present status of International defence cooperation activities and suggests measures to overcome the challenges.

International Defence Cooperation as Seen by Some World Powers

Within the overarching umbrella of security cooperation and defence diplomacy, defence cooperation facilitates consultation rather than confrontation, reassurance rather than deterrence, transparency rather than secrecy and interdependence rather than unilateralism. Ministry of Defence(MoD), India defines defence_diplomacy as those actions undertaken through the exchange of high level defence related visits and dialogues on security challenges. Defence co-operation is defined as activities covered by training exchanges, combined exercises, sourcing, development, production & marketing of defence equipment and other forms of cooperation. UK perceives defence diplomacy as those efforts that seek to increase stability and security, changing attitudes and perceptions through "disarmament of the mind" and defence cooperation as an arrangement where two or more nations work together to enhance military capability. US A's perception of defence cooperation covers military alliances and agreements and caters for joint operations, interoperability, access and influence while security assistance refers to various (international) security assistance programmes which include foreign training, courses and material assistance. Australia perceives defence international engagement as all those activities that the Australian defence forces and dept of defence officials undertake with

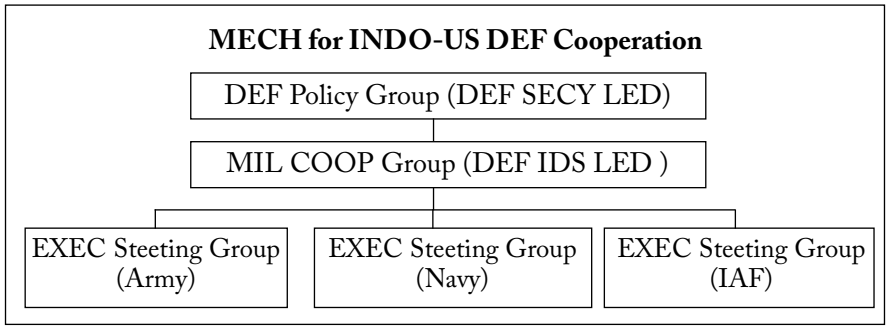
foreign defence and security organizations and defence cooperation as a sub-set of international engagement, which includes only those activities funded by Australia from a separate defence cooperation budgetary allocation.

Indian Defence Cooperation Activities

India conducts a wide range of defence cooperation activities. Under military training activities courses are conducted at military training institutes for foreign military officers are under Indian Technical and Economic Cooperation programme(ITEC) I/II and self finance schemes. Specially structured training packages are conducted for certain countries as per their requirements. Indian training teams, both long and short term have been training cadets and officers in various countries. Military Academies carry out cadet and instructor exchange programmes. Sports, adventure and cultural activities are also an integral part of military training. Next major activity is gifting of military hardware (gratis/sale at friendship rates), procurement, joint Research & Development and production ventures. Under the peacekeeping operations India has sent peacekeeping contingents (both for peace sp and peace enforcement), staff officers and military observers to a no of countries. We have also trained a number of foreign officers at USI Centre for UN Peace Keeping. Other misc activities include exchange of visits/ study teams / delegations and participation in seminars and conferences.

Military-To-Military Cooperation Mech

The mechanism consists of bilateral talks, staff talks ,policy groups, consultative groups ,military cooperation groups and exec steering groups. Present mechanism for Indo-Us Defence Cooperation is an ideal model for conduct of defence cooperation. A diagrammatic layout is as under :-



Organisation For International Defence Cooperation

Defence Co-operation Policy of USA

Thrust area of US policy flows out of and is related to the US national policy and the msn of its army. It views continued American leadership as world's most important force for peace. Some of the thrust areas are:-

- Increased cooperation in confronting new security threats that defy borders and unilateral solutions.
- Strengthen alliances to defeat global terrorism and proliferation of WMD.
- Strengthen military and diplomatic tools necessary to meet challenges.
- Promote interoperability with friendly armies and robust military alliances. *Preserve the peace and security, and provide for the defence of the US, the territories, commonwealths and possessions, and any areas occupied by the US.
- Support national policies and implement national objectives.

Defence Cooperation Policy of France

Thrust areas of the French defence cooperation policy are as follows :-

- Partnership within the EU and allies in the NATO (research in interoperability).
- Assistance to developing countries where instability threatens French interests, viz Africa.
- Influence to promote its views or support exports.
- Operational support to countries in crisis or after crisis (Cambodia and Afghanistan etc).
- Objective of defence Cooperation is to ensure an environment of security and stability through conflict prevention and support French defence assets (equipment and technology).

Defence Cooperation Policy and Model of India

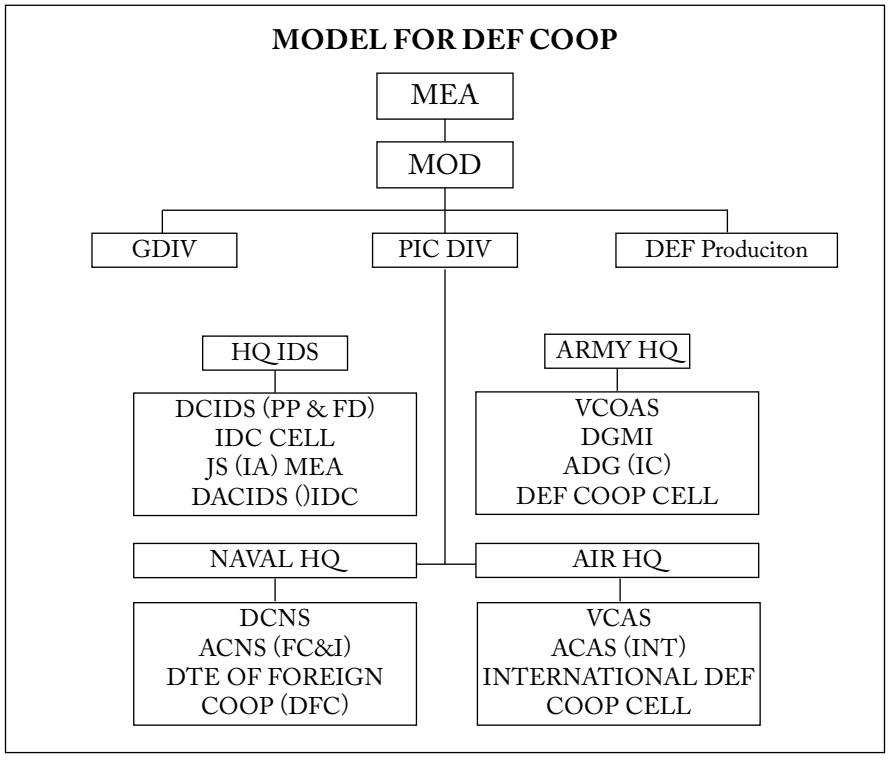
While there is no policy document in the public domain initiated by the MoD, based on the MoD Annual Report and statements from the successive Prime Ministers and Defence Ministers one can derive the Drivers Of India's Defence Cooperation policy. Army to Army cooperation must be used as a tool to enhance national security in consonance with other key players. Based on the requirements of our national security, drivers for India's def cooperation

are as follows:-

- Immediate neighbours should be engaged across a wide spectrum, on priority, for achieving regional security and stability.
- A focussed approach towards strategic neighbours to achieve convergence on mutual security concerns.
- Countries which enhance Own Defence Industry's Capability
- Other important world powers should be engaged to achieve max pay-offs.

Model of Indias Defence Cooperation

Existing model at the National level is given below digramatically :-



Defence Cooperation In Indian Army

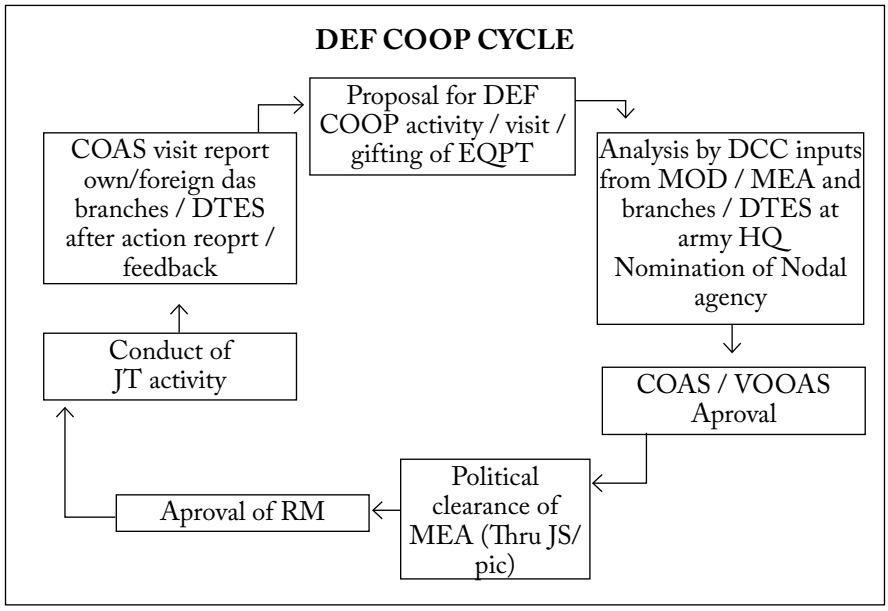
Role of Additional Directorate General Of International Cooperation

This is the nodal agency for formulating the defence cooperation policy (army-to-army) in coordination with MoD & ministry of External Affairs(MEA) in order to proactively synergise defence cooperation in an effective manner. It formulates policy for defence cooperation (army-to-army) with various foreign countries and prepares and implements road maps for defence cooperation based on the enunciated policy (coordination with MoD, MEA , own and foreign attaches and various branches/directorates). It is also the single window agency for all army related defence cooperation activities. Prioritisation and vetting of Annual Foreign travel Plan and non- Annual Foreign travel Plan visits relating to defence cooperation with foreign countries is also done in this additional directorate. It also identifies aims and objectives of high level visits, briefing prior to in/out visits and follow-up points of all in/out visits to ensure optimisation. Laying down priority for allotment of courses, seminars and training teams is done here.

Defence Cooperation Cycle

From the time a defence cooperation proposal is initiated till it fructifies and the activity is completed, a no of agencies get involved and a lot of time is spent in coordination at various levels. The whole process is quite complex. It has been explained below diagrammatically. *(See Diagram-3)*

The first step in the defence cooperation cycle is initiation of proposal by a directorate at Army HQ .The defence cooperation activity proposal is then examined in detail by the Defence cooperation Cell of the additional directorate of International cooperation. The Cell also obtains inputs from MoD, MEA and certain other directorates of Army HQ. After detailed analysis a nodal agency is nominated to conduct this activity till its completion. After this COAS or VCOAS approval is taken . Following the approval the proposal goes for political clearance of the MEA through JS (PIC) of MoD. After political clearance the proposal alongwith its financial effect is sent to MoD (Finance). After the concurrence of MoD (Finance), the approval of Defence Minister is obtained . After the approval of Defence Minister, the activity takes place . A detailed report is sent to Defence cooperation Cell by the Nodal agency on completion of the activity. Defence cooperation Cell takes action



on the recommendations given in the Report and also gives a feedback to the concerned directorates. This feed back then helps in improvement in similar activities being undertaken in the future.

Major Defence cooperation Activities

Since 2002 when defence cooperation got major impetus, Indian Army has conducted and participated in a large no of activities.

Joint exercises

These are being conducted with USA (Ex Yuddha Abhyas, Ex Red Flag, Ex Malabar, Ex Shatrujeet, Ex Cope India) , Russia(Ex Indra), Mongolia, Thailand, Seychelles , Singapore, Maldives, UK (Exercise Ajeya Warrior, Ex Konkan, Ex Indradhanush), Uzbekistan , China (Ex Hand in Hand) and France. Broadly, joint exercises aim at sharing of operational and doctrinal expertise, training and capability enhancement of one's own military, strengthening of ties with other countries and sales of weapons and military technologies. It also allows for the examination and imbibing of 'best practices', creates ability to operate alongside and enhances domain knowledge, through a variety of information sharing mechanisms.

Training Courses

With the interest of foreign armies for training in Indian Army establishments increasing considerably, the armed forces personnel from neighbouring countries and other global countries are regularly attending various training courses at our Army training establishments. An active exchange of training courses is on-going with USA, UK, France, Australia, Nigeria, Oman, Egypt, Kenya, Botswana, Lesotho, Zambia, South Africa, UAE, Sri Lanka, Nepal, Bhutan, Myanmar, Thailand, Singapore, Vietnam, Cambodia, Mongolia, Seychelles, Maldives and Indonesia.

Military Equipment

Indian Army has supplied or gifted military equipment to Sri Lanka, Bhutan, Nepal, Myanmar, Maldives, Mauritius, Mongolia, Afghanistan, Cambodia, Seychelles, Tajikistan, Nigeria and Zambia. The equipment has been supplied based on the requirements of the country. Assistance in IT is being provided to Myanmar, Indonesia, Nigeria, Tajikistan, Cambodia and Brazil.

Personnel Exchange Programmes

Cadet exchange programmes are_on-going with Australia, UK, China, Thailand, Indonesia, Egypt, Nigeria and Singapore. Sports and adventure activities are on-going with Myanmar, China, Thailand, Sri Lanka, Singapore, UK, Nigeria, Egypt, Bhutan and Kazakhstan. Band festivals/cultural exchanges are ongoing with Sweden, Iran, France, Greece and Japan. Seminars and conferences are_attended regularly in Israel, Nigeria, USA, UK, Japan and Australia. An Indian military contingent took part in the parade to commemorate 70th Anniversary of 'Victory Day' in Moscow in May, 2015 which was also witnessed by the President of India. Similarly a marching Contingent of the French Army participated in our Republic parade 2016.

Military Training Teams

Bilateral relations with countries where Indian Military Training Teams are deployed are extra special as evinced in Bhutan, Lesotho, Zambia, Laos, and Tajikistan etc. The presence of training teams assist in building links with the host country's military thereby supplementing the efforts of the diplomatic corps and at times even off setting not so cordial relations at the diplomatic level. India is continuing its wide-ranging support for stabilisation of the security situation in Afghanistan. India has assisted Afghan National Army

(ANA) in building its capacity through military training, medical training and medical assistance to security personnel.

Challenges And Way Ahead

Spinoffs

International defence cooperation has broadened our Armed Forces horizons. To some extent we have moved away from Pakistan /china centricism and 'combat fixation'. It has enhanced status of the Indian Armed Forces both within and outside the country. It has helped Indian Govt for international diplomacy with military regimes viz Myanmar. We have invested in long term rapport building through training and vibrant interaction with Armed Forces of many countries. We have received valuable inputs in development of own doctrine, equipment and training. It has facilitated 'out reach' of our defence industry. Some other tangible spin offs include facilitation of own operations against Indian Insurgent Groups in Myanmar and Bangladesh, generation of goodwill during Tsunami disaster, Nepal earthquake and cyclone in Myanmar.

Challenges

While the defence cooperation activities have increased manifold there are many challenges which need to be tackled at various levels of the hierarchy.

Ministry Of External Affairs

Before any defence cooperation activity is undertaken with a foreign country, political clearance has to be obtained from the MEA. The Ministry has not issued any comprehensive guidelines on political clearance policy for Defence cooperation with the result that all cases are dealt separately by territorial divisions of the Ministry. This results in delay and cancelation of a no of events at the last minute which causes embarrassment. There is a need to have a central section in the ministry for clearing defence cooperation proposals.

Ministry of Defence

Like MEA, MoD too has not spelt out its Defence cooperation policy in a comprehensive manner in a separate document. Besides this the other challenge is that the final authority to permit any defence cooperation activity lies with MEA. MoD has its focus on defence industry and is equipment driven. There is a disproportionate control of the MoD (Finance Division)

on the proposal approvals . Decision-making/approvals process is completely centralised resulting into delays . There is no integration of military staff with the MoD which results into lack of subject matter experts. Dedicated funds within defence budget are not allotted for defence cooperation.

Services HQ

The Services HQ have very limited powers of decision making delegated to them. Majority of proposals have to be approved by MoD . There are issues of inter-service coordination and rivalry. Defence cooperation still an evolving field It's rapid progress, scope and quantum of activities has overshot anticipation. Within the Service HQ there is inadequate coordination within branches and Directorates. Still there is glamour of foreign travel which at times results into detailment of personnel who do not deal with the subject for which they are going abroad . There is inadequate representation of own defence attaches/ advisors abroad.

Way Forward

Policy formulation

There is urgent requirement of framing policy guidelines by National Security Council, MEA and MoD and dissemination to the Service HQ and HQ IDS. The policy document must lay down interse priorities for engagement with various countries .

Integrated MoD

As recommended in Kargil Committee Report full integration of Service personnel with MoD must take place to enable in-house inputs and analyses. Authority, responsibility, resources and accountability for defence cooperation must be clearly spelt out. The Ministry must issue clear cut directives for execution of defence cooperation plans including aims and objectives.

Services HQ

Services HQ should consider defence cooperation as one of the imp tasks as done by the British Army. It must review its policy of restrictive "contact with foreign nationals". Without adequate interaction with foreign defence personnel defence cooperation can never be completely successful. Services need to allocate higher priority in respect of defence cooperation with immediate

and strategic neighbors. Need for better inter-branch/directorate coordination needs no emphasis.

Defence attaches

There is a need for adequate representation, accreditations and staffing of our defence attaches/ advisors abroad. They are our points men to increase our defence cooperation engagements with the respective countries where they are posted. Our Ambassadors/ High Commissioners need to give them more support from our missions to give impetus to this activity. Adequate budgetary allocation should be made to the defence wings of our missions abroad for defence cooperation. Annual Defence attache conferences at New Delhi will help planning and better coordination .

Proposal for South Asia Centre for Defence cooperation Studies

On the lines of Asia Pacific Centre for Security Studies located in Honolulu, Hawaii , MoD can establish South Asia Centre for Security Studies at Pune to address regional defence cooperation issues, and invite military and civilian representatives of the South Asian nations to its comprehensive programs on these issues.

Miscellaneous Actions

Presently just a few service personnel are on cross deputation with MEA. This number needs to be increased gradually to a figure which is adequate to provide in house advice on defence matters to the Ministry to give impetus to defence diplomacy. Only initial engagement with a country should be with MEA's political approval, thereafter it should be delegated to executing agencies. MoD needs to earmark a separate defence cooperation fund. We must extend liberal credit lines for neighboring countries for this activity. Export of arms & equipment should be at competitive rates. A regular review of defence cooperation plans with MEA and MoD should be encouraged .

Conclusion

Despite ambiguous policy from Govt, International defence cooperation is on the upswing. In order to exploit the full potential of the tool of defence cooperation, it is imperative that various agencies involved with the conceptualisation of the defence cooperation events (the MEA, MoD, Headquarters Integrated Defence Staff and the three Services) evolve a mutually

consulted both long term and annual defence cooperation plan so that these are implemented smoothly and with minimal disruptions. Creation of Defence cooperation cell in the Army and it's equivalent in the Navy and Air Force is a very important first step towards institutional sp for defence cooperation. In the recent years Indian Army has upgraded the post of Chief of International cooperation to a Two star general like the other two services. India has an active defence exchange programme and an elaborate matrix of confidence-building measures with China that have helped promote greater trust between the two armed forces. There may be a need to supplement diplomatic engagement of Pakistan by engaging its military through military diplomacy. The desirability and contours of this would be required to be thought through. While post Pathankot Airbase attack, the

political environment may not be truly conducive for this kind of an initiative,

however, once Pakistan offers assurances which meet our security concerns,

we could gradually move towards consolidation of Confidence Building Measures on the Line of Control. Thus Defence cooperation can make positive contribution towards national diplomacy in the form of defence diplomacy.

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Major General S H Mahajan SM (Retd)

Major General S H Mahajan during his 38 years of Army service, has served in all the border areas of our country. The General Officer is an alumni of the Defence Services Staff College, Wellington, Army war College ,Mhow and the National Defence College (NDC), New Delhi. Maj Gen Mahajan has seen active service having commanded 4 MARATHA LI in Jammu & Kashmir and 11 Mountain Brigade in Assam. For his distinguished service in Counter Insurgency Operations in Assam, he was awarded Vishisht Seva Medal. The General Officer has commanded 23 Infantry Division as part of strike corps on the Western Front. For his distinguished service as Major General Administration of Northern Command he was awarded Sena Medal.

He has served with United Nations as a Military Observer in Iran after the ceasefire in the Iran Iraq war in 1989. As Deputy Director General Mlitary Intelligence (Foreign Division) he was responsible to plan and implement International Defence Cooperation for the Indian Army. He has served as Director Military Affairs at Disarmament and International Security Affairs Division, under the Ministry of External Affairs, Delhi where he was dealing with Arms control of conventional weapons. During this tenure he attended several meetings at UN Conference on Disarmament, Geneva (Switzerland) . He has travelled widely and has visited 18 countries. After superannuation in Jan 2013, presently he is Deputy Director of CASS. He has been nominated by MoD as a member , Committee of Experts to recommend measures to enhance combat capability and rebalance defence expenditure of the Armed Forces.

Hard Kill UAV Technology and India's Operational /Targeting Options

Gp Capt Murli Menon (Retd)

Introduction

This piece is being written whilst holidaying in New York, having just watched Prime Minister Modi's impressive rendition to the joint session of US Parliament. One of the key fallouts of this visit is India's plausible entry into the hallowed Nuclear Supplier's Group (NSG) and the Missile Technology Control Regime (MTCR). Incorporation of the India- US LEMOA (Logistic Exchange Memorandum Of Understanding) in the coming days would further strengthen the strategic partnership of the "natural allies", besides, significantly opening the doors to India for certain cutting edge space and military technologies. Key among this is the Predator drone/ Hellfire missile technology, a lethal weapon system which has broken the back of terrorist entities, in recent times, in Pakistan, Afghanistan and Yemen. The 21st May 2016, US Predator attack on Pakistani Taliban Chief Mullah Mansour Akhtar within the territory of Pakistan's Baluchistan province raised the pertinent question in many an Indian strategic mind as to when the US would act likewise against the ilk of Hafiz Syed or Dawood Ibrahim, key strategic personalities in our targeting spectrum. Soon we would have the capability ourselves, it appears, to take such targets out, besides also Pakistan's other strategic assets.

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 111–132

US Predator or special forces action on Pakistani territory have caused muted responses as expected. India would not have this luxury given the traditional animosity of the adversary. But opportunities would present themselves, either during the next hot war, or even as Operations Other Than War (OOTW). It is time our operational planners addressed our targeting priorities for these contingencies (as they well might already be doing!!).

Planning Considerations

Radius of Action

Mainly there are some important aspects to be considered here. The first – and most important – is the Predator radius of action. The stated radius of action of the Predator class of drones is 500 nautical miles or around a thousand kilometers. An extract of the operational manual of the Predator (declassified version available on the web) is attached as an an an annexure to this article. From this it will be seen that normally only one Predator system is deployed at one operational base, and this too could be either split located or co -located. The entire system comprises four air vehicles (drones), one Ground Control System (GCS) vehicle and another "Trojan Spirit" SATCOM Support vehicle along with a manpower of 65 personnel. This one operational unit is stated to be operationally deployable within 24-48 hours in four C-130 aircraft or two C-17 aircraft. Another 24-48 hours would be required to make the system operational at the ops location. It is recommended that Predators do not get deployed at main Air Force bases for obvious reasons of discretion and other security considerations. Operational sites should cater for 5000 feet of hard top surface, either at abandoned/ satellite air strips or even on suitable stretches of highways.

Training

Facilities for flying training and live firing for pilots and on job training for technicians need to be catered for. Some kind of air to ground range facility would be required for live shoots. A bank of pilots need to be built up. given the existing tight aircrew manning situation. Retired pilots could always be called in for this important task. The area chosen for training and operational deployment should be compatible for UAV operations in that other aerial activity ought to be minimal there and suitable air traffic facilities for de-confliction should exist.

Organization and Acquisition

The organization chart followed by the Americans envisages operations under the Air Combat Command, With Nellis Air Force base and Indian Springs auxiliary base involved. Their theatre deployments would be according to the other threat scenarios globally, including from on board some aircraft carriers. We could consider either placing them under our operational Commands (mainly the Western Air Command as that is likely to be involved more often than not) or even an independent line organization under Air HQ_ops staff could be envisaged, keeping in mind the criticality of the mission nationally. Separate assets for battlefield and terrorism targets could be envisaged, indeed as practiced by the CIA and USAF in the demarcation of onus. We should also cater for ship borne deployment to cater for targeting from the Arabian Sea. Of course India is in a happy situation in this context right now, with the capability to optimally exploit the 1000 km radius of action from western, north western and eastern quarters of the expected target area. Once all aspects are considered we would also arrive at the total numbers of systems that we need to acquire. Depending on TOT provisions down the line, indigenous production may be an option though initially it does appear that the numbers acquired would be limited and off the shelf.

Target Vulnerability analysis

ultimately drone operations would need to be dovetailed into Air HQ_or Command Air Tasking Orders (ATOs). To enable this, vulnerability analysis of expected targets is crucial. Depending on factors such as hardening, countermeasures, dug in emplacements, available intelligence etc one would arrive at the requisite numbers of missiles on target. Battle Damage Assessment is easy in these missions as the target is continuously covered digitally by the Predator's Synthetic Aperture Cameras themselves. Repeat attack requirements could be decided therefrom.

Likely Targets

Taking a leaf out of the American experience, it is likely that we would also opt to have a system of kill orders emanating right at the top for terrorism linked personalities– either from the PMO/ NSA combine or the National Security Council , given the significance and political importance of the expected neutralization. Different tasking chain for war situations and OOPS may also be on the anvil. During active war the IAF could evolve its own tasking

mechanism, as indeed done for strategic air targeting. As far as personalities go, the likes of Hafiz Syed an Dawood Ibrahim would be priority of course. Other individuals directly impacting our security and- being sheltered by neighboring inimical entities, training camps for terrorists, tactical (NuSAR comes to mind) and other nuclear installations would be fair game. Since the numbers of hard kill drone assets are expected to be very limited, at least during initial years, the nation needs to employ them with utmost discretion. Target weapon matching is key here. Other important strategic or tactical targets could be engaged by other suitable weaponry, such as stand off aerial weapons and the Brahmos for hardened targets or Harpy drones for radar emitters.

Vulnerabilities of the Weapon System

There are certain operational constraints of the system that needs to be kept in mind.

The first is of radar signature. The Predator is not designed for reduced radar signature, thus it is possible that it would be picked up by Air Defence radars and an intercept attempt is likely. Secondly there could be some weather limitations such as low cloud base, precipitation etc. Though the maximum range of the Predator is given as 500 nautical miles practical operational range would be in the region of 200-300 nautical miles. Though designed for 40 hours of flying endurance, practical figures would be half that figure, viz 20 hours, especially in the "heavy"configuration with additional sensors. Another Operational constraint could be the integration of signal intelligence inputs, from different sources in our context, such as Wireless Experimental Units, NTRO, R& AW and others. The weapon system comprises within the Trojan Spirit SATCOM terminal, link ups to other intelligence gathering agencies and sensors. We would need to adapt our systems to integrate the ELINT / SIGNT from NTRO and R& AW, as also from onboard ELINT systems of our AWACS/AEW and Aerostats. The Predator does not feature any aerial refueling capability and hence its endurance of around 20 hours on station.

"Morality"issues in drone attacks

There has been much media debate the world over on the morality of targeted killing using drones. We still do not know for sure as to when and if Predator technology would be available to us. But in any event, India needs to be prepared for intrusive media attention and probity on these secret strategic air campaign missions. The USA was itself dead against targeted killings when the Israelis

resorted to it against the Palestinians in Gaza. But things changed after 9/11 and terror attacks assumed the seriousness of wars. New laws were passed and the POTUS began authorizing targeted killings himself. India has had enough damage done to its national psyche by terror elements to not treat them as enemies of state warranting immediate neutralization. Drone technology now affords the capability to achieve this out of sight and out of public mind.

Conclusion

10. The purpose of this article is definitely not to tell our operational planners how to do their job. It is intended only to foster thinking and debate, within the system and without, on the various issues involved, considering that the Indian Air Force is going to be embarking on an altogether new operational domain, both in terms of technological challenges and political and international repercussions. Remember the Americans have chosen to organize their predators both under their Air Force as well as the CIA. We may choose to have drone missions- at least initially till enough experience is gained – under IAF command and control. We may subsequently choose to induct the R&AW into the ambit, should the powers that be so decide. This could offer vital deniability advantages. But, like stated earlier, it is an altogether different ball game and prudence would dictate keeping the assets under the Air Force initially. One factor which would be in our favor would be the comparatively compressed expected area of operations in our context. This would have significant impact on the communication and siting challenges, since we would be virtually operating across our borders, a luxury the Americans did not gave thanks to their global outreach.

ANNEXURE

Reference- Endurance UAV CONOPS US Air Combat Command 3 Dec 1996- Version 2 http://fas.org/irp/doddir/usaf/conops_uav/part03.htm (Source: Internet)

Section 3 - Operations

3.1 GENERAL Endurance UAVs will be deployed worldwide to support joint combatant forces in worldwide peace, crisis, and wartime operations such as: Battlespace dominance (wartime); Regional crisis, limited deployment operations; and Operations Other Than War. The high mobility of these vehicles and their accompanying ground-based system components

will allow flexibility in selection of operating locations and employment. This capability will enhance the systems utility, survivability, and readiness. Specific beddown decisions will be made by theater commanders within their current infrastructures.

3.2 ORGANIZATION Predator UAVs will be aligned under Air Combat Command's Air Warfare Center and assigned to the 57 WG at Nellis AFB with flight operations conducted from Indian Springs Auxiliary Air Field NV. Within the 57 WG endurance UAVs will be assigned to the 11 RS (see Figure 3-1). The 11 RS was activated 29 Jul 95, for the sole purpose of integrating Predator UAVs into air operations. The 11 RS will be subdivided into two flights, operations and maintenance. All squadron personnel will have a worldwide commitment to deploy in support of tactical operations or other tasking as appropriately approved.

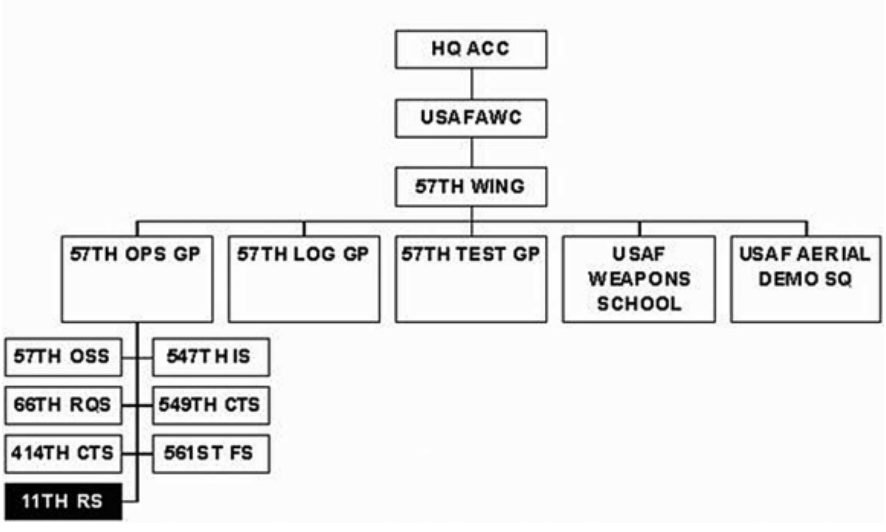


Figure 3-1: Endurance UAV Organization Chart

3.3 BASING Basing of endurance UAVs will follow a main operating base (MOB) - non-MOB concept. Non-MOBs may be any geographical location where US tactical forces may be committed. Non-MOBs will be established by theater planners.

3.3.1 CONUS MOB UAVs under the operational control of ACC will not operate from an active Air Force installation until certified by the ACC/

DO. The MOB for the Predator endurance UAVs will be at Indian Springs Air Force Auxiliary Field. The commander of the 11 RS maintains an office at Nellis AFB. The Global Hawk and DarkStar MOBs are TBD. The 11 RS MOB will conduct initial qualification training (IQT), mission qualification training (MQT), and continuation training (CT). UAV operations from an Air Force satellite or auxiliary operating area/site/installation may be required as an interim basing option until endurance UAVs can be reliably bedded down Exercise support and operational support can be conducted from both MOB or Non-MOB locations. Minimum criteria for the MOB (Nellis AFB - Indian Springs Auxiliary Field) include:

3.3.1.1 Site with a low volume of ground and air traffic or an existing AFB with an auxiliary airfield/site (off major air routes, not near major airports or traffic patterns - minimum interaction with visual flight rule (VFR) traffic).

3.3.1.2 Site with a minimum landing strip of 5,000 feet (prepared, smooth hard surface).

3.3.1.3 Access to restricted airspace and AF-joint training areas (collocated if possible) (i.e., Ft. Irwin, Nellis and White Sands ranges, etc.). These criteria may not apply to Non-MOB employment. Currently the need to access to special use airspace is a result of the status of agreements between USAF and the FAA for UAV airspace integration. Reference Para 3.11 for details.

3.3.1.4 Access to a support base.

3.3.1.5 Facilities/or areas to site maintenance facilities to perform maintenance on UAVs.

3.3.1.6 Access to/or areas to site hanger facilities, or other facilities to provide environmental protection for UAVs.

3.3.2 Non-MOB Operating Locations Non-MOBs for the UAVs should be selected with criteria similar to that of the MOB. Maintenance capabilities may be reduced (compared to the MOB) by varying degrees depending on theater support capabilities or operational tasking. Each of the NON-MOBs will be capable of supporting projected tasking (D to D+30) with a maintenance and support package of support equipment, spares, and consumable stock, etc.

3.3.2.1 The maintenance and support packages will include highly mobile, six-day support kits for possible dispersal operations within each theater. These kits will consist of critical mission system components and other material spares, such as tires, seals, gaskets, oil, etc., to support initial orbit surge requirements until intermediate level maintenance (ILM) packages arrive. The selection of spares, other components, and consumables for these kits will be compatible

with a limited maintenance capability to remove, replace, and perform limited repair using predetermined/pre-positioned SE. Kits for each potential dispersal location will be air transportable in one aircraft no larger than the standard theater distribution system type aircraft.

3.3.2.2 During periods of hostility, aircraft may be deployed or dispersed from the MOB, or Non-MOB, to support projected tasking or to improve survivability. The mobile support kits will also be deployed from the Non-MOBs to support basing requirements. Fuels and other consumables not part of the mobile support kits, or aviation and immediate level maintenance organizations, will be deployed to Non-MOB as determined by other planning documents. It should be noted, however, that deployment or dispersal of aircraft from the Non-MOBs may result in decreased orbit coverage/mission effectiveness for Predator and DarkStar.

3.4 DEPLOYMENT/REDEPLOYMENT

3.4.1 Deployment basing of these UAV systems will be the prerogative of the supported theater CINC/JTF Commander, in coordination with the supporting operating command, USACOM/ACC.

3.4.1.1 Predator The Predator's500 NM operational radius will need to be considered when choosing an operating location. The basic deployable MAE UAV system (4 two air vehicles, GCS, TSII, support equipment, and Personnel) are transportable in C-130 and C-141 aircraft (this is exclusive of the TROJAN SPIRIT II van). GCS trailers are not configured for air mobility and require special handling to load and unload from transport aircraft.

3.4.1.2 Global Hawk The Global Hawk's 3000 NM operational radius offers commanders the JFACC considerable flexibility in choosing an operating location. For example, bases may be used outside the immediate theater of interest, freeing up ramp space for strike aircraft. The Global Hawk capability will be transportable to any theater of operations by airlifting moving the ground and support segments and self. The ground and support segments will require three C-141 equivalent loads to provide one single continuous orbit.

3.4.1.3 DarkStar The DarkStar 500 NM operational radius will need to be considered when choosing an operating location. DarkStar air vehicles and payloads may require transport to the theater of operations dependent on the range from garrison to the Non-MOB UAV operating location base.

3.4.2 Deployment Options and Requirements The Endurance UAV systems are readily deployable, with pack-up for transport in 24 to 48 hours, and

set-up/commencement of operations also taking 24 to 48 hours after arrival at the operating site. A fully deployed system will be able to sustain continuous operations for thirty days without re-supply. Maintenance and logistics personnel will maintain the critical ground spares and line replaceable units (LRUs) as well as provide the necessary power generation and environmental control equipment required by the ground station components. Depending on the specifics of the theater environment, operational and logistical considerations, a number of deployment options exist that could include a mix of all three classes of UAV capabilities. Due to operational radius of action, Predator and DarkStar missions will normally be flown from Non-MOB deployed sites. Predator will always deploy as a system as defined in Section 2 of this CONOPS. Even though Global Hawk and DarkStar are capable of sharing ground-based system components (MCE, LRE, and PLRE), the different operational characteristics and the technical limitations of the DarkStar will most likely demand independently deployed capabilities. Figures 3-4, 3-5, and 3-6 illustrate notional mission profiles for the Predator, Global Hawk, and DarkStar, respectively.

3.4.3 Forward Deployment Option and Requirements A fully deployable Predator UAV system will require four air vehicles, a GCS, support equipment, a Trojan Spirit II van, and 65 personnel. A complete Predator system will require four C-130s or two C-141s for deployment. This deployment option provides resources to support one near continuous Predator orbit (gaps in orbit coverage are due to the baseline system limitation of the GCS only being able to control one vehicle at a time).MAE UAV orbit. A fully deployable HAE UAV weapon system is envisioned to include a compliment of Global Hawk or DarkStar, or both air vehicles, a MCE, LRE, PLRE, a SE kit (capable of supporting operations for 30 days), and personnel. The HAE UAV ground elements are designed to be readily deployable in three C-141 equivalent loads. The Global Hawk air vehicle is self deployable. The DarkStar air vehicle will most likely require air transport by C-17, C-141, or C-5 aircraft depending on Non-MOB locationsC-130 or larger aircraft. The requesting agency will be required to provide support unique to the operating area and environment if it is not already provided as part of the HAE UAV deployment packages.

3.5 EMPLOYMENT

3.5.1 Predator Employment The Predator system will always deploy as a complete system and all of the system components will be collocated at the Predator vehicles launch and recovery base. The current baseline system constraints require that Predator vehicles not operate within close proximity to one another. As a result, it is not likely that more than one system will be operated from a single base.

3.5.2 Global Hawk and DarkStar Employment

3.5.2.1 Collocation Deployment Option This deployment option allows the MCE, LRE, and air vehicles to be located at the same site. With all components collocated, the support requirements will be less intensive than the split-site deployment option.

3.5.2.2 Split-Site Deployment Option and Requirements Split-site deployment provides operational and/or logistical flexibility by allowing the air vehicles to operate from a site remote from the MCE. The LRE and the UAV may be forward (or rear) deployed to reduce transit time, improve on station endurance, and/or retain the MCE at a favorable site (due to security, collocation with exploitation sites, communications, logistics, etc.). If the MCE and the LRE/UAVs were both deployed to distinctly separate sites, the support requirements will be more extensive than a collocation deployment option. Support requirements may be less extensive with the Global Hawk if operations from the MOB can be accomplished. Figures 3-8 and 3-9 provide sample mission profiles for the Global Hawk and DarkStar using split-site operations. Connectivity will be described in Section 6.

3.5.2.3 MOB Option and Requirements One operational scenario includes no deployment of ground stations and equipment. The air vehicle will be employed from a main operating base (MOB) and will data link tasked sensor data to the MCE or existing exploitation sites. Required support activity may include access to the command and control architecture (SATCOM use and coordination). This option is feasible only for the Global Hawk system.

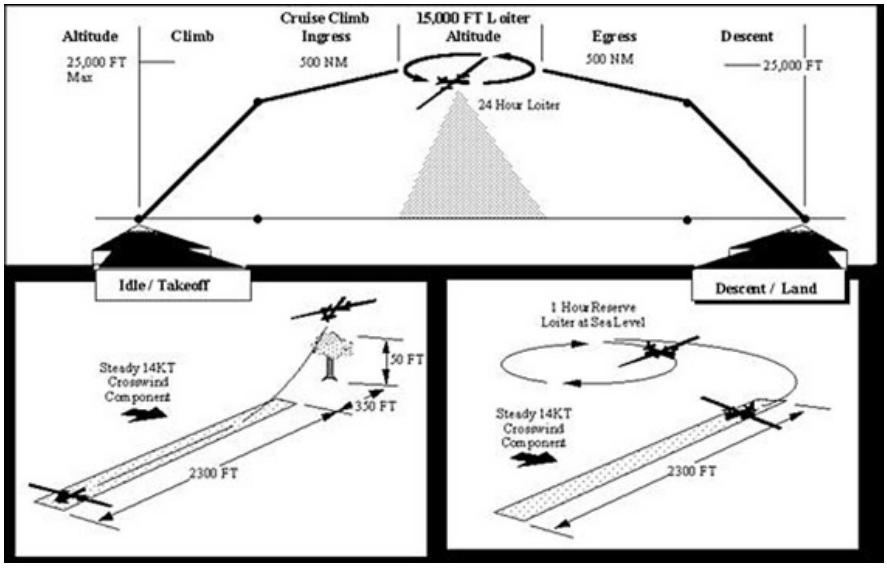


Figure 3-3: Predator (Tier II) Mission Profile

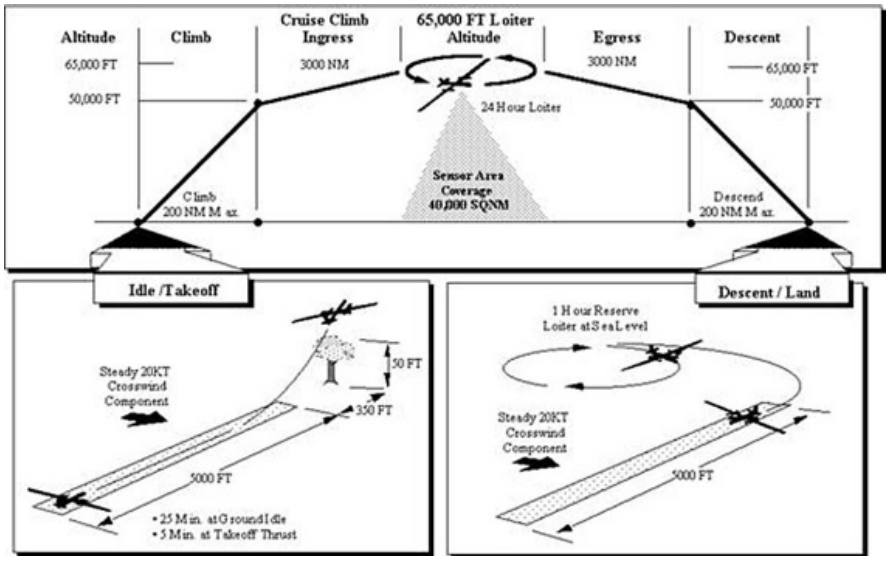


Figure 3-4: Notional Global Hawk (Tier II+) Mission Profile

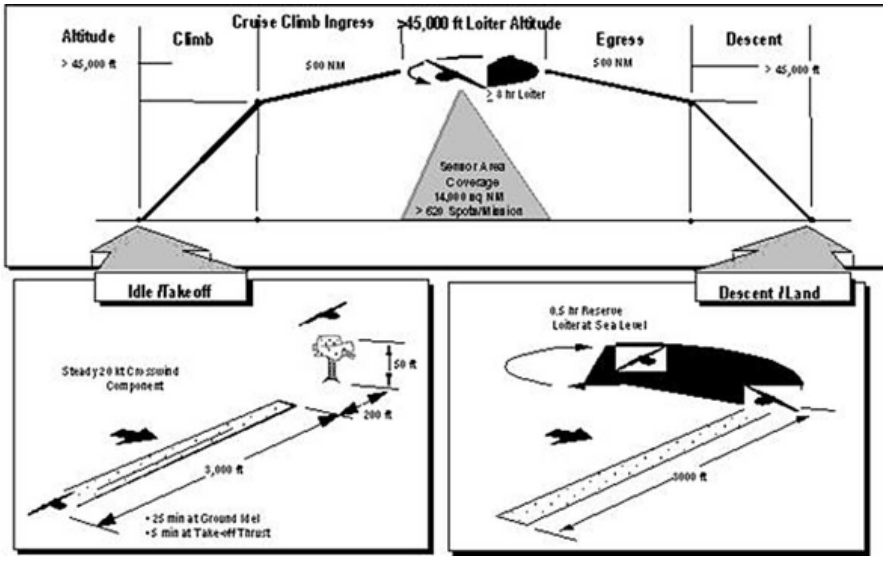


Figure 3-5: Notional DarkStar (Tier III-) Mission Profile

3.5.2.4 Predator GCS Operations Both the Predator mission payload and aircraft control will be operated from its GCS. The Predator's GCS is a single element composed of a group of subsystems and operator stations capable of mission planning, flight planning, launching, controlling, monitoring, preliminary sensor analysis, and recovering the vehicle. EO and IR video data will be passed via LOS or UHF/Ku-Band Satellite data link to the GCS. SAR framed imagery will require a Ku-Band Satellite link. Predator's imagery analyst then prepares the collected data for further dissemination. Warfighting CINCs will provide an exploitation cell compatible with the specific theater comm/intel backbone and the Predator GCS. The most recent deployments of the Predator system have been augmented by a "Rapid Exploitation and Dissemination (RED) Cell." From the exploitation cell, imagery is piped through a Trojan Spirit van via commercial satellite to the desired customer (see Figure 3-7).

3.5.2.5 Global Hawk and DarkStar LRE Operations The LRE is a subset of the MCE, providing the functionality for mission planning and air vehicle command and control. The LRE contains a mission planning workstation and a command and control workstation. During split-site operations, the senior operator will function as the local mission commander until air vehicle control is passed to the MCE (see Figures 3-8 and 3-9). The primary difference between

the LRE and MCE is the lack of any wide-band data links or image processing capability within the LRE, and the addition of a Differential Global Positioning System (DGPS) system at the LRE to provide the precision navigation required for ground operations, take-off, and landing. The LRE mission planning capability is fully redundant with that in the MCE, which allows the LRE to make updates to the mission plan received from the MCE prior to launch or while enroute to/from the handover point; however, the LRE lacks provisions for automated reception of threat and weather data and will require these data from the MCE. Command and control is executed over either the UHF SATCOM or LOS data links; voice coordination with airspace control authorities can be accomplished through the air vehicle relay (over UHF SATCOM only, and only through the Global Hawk) or via a dedicated ARC-210 VHF/UHF voice radio. The UHF SATCOM and LOS radios are interchangeable, providing an in-line spare for both links. Take-off and landing accuracy is obtained using DGPS; the DGPS system computes pseudo-range corrections to received GPS signals and transmits those corrections to the air vehicle, providing accuracies of 1.1 meter within 20 nm of the LRE. The pseudo-range corrections are transmitted over a separate VHF link for Global Hawk, and are integrated into the command and control uplink signal for DarkStar. (DarkStar does have a separate backup VHF link for DGPS corrections should the C2 link fail.) The Global Hawk DGPS is designed for Special Category One (SCAT-1) operation. Once SCAT-1 systems become available and their use widespread, Global Hawk should be able to land at any airfield with an operable system, providing readily available alternative landing sites. In the interim, the PLRE will be available for rapid deployment within theater to recover either a Global Hawk or DarkStar vehicle at an alternate recovery location.

3.5.2.6 Global Hawk and DarkStar MCE Operations The MCE is responsible for mission planning, including flight planning, communications planning, and sensor planning. Once the mission plan is completed, the MCE electronically transfers the plan to the LRE for loading into the air vehicle. After the LRE hands off the air vehicle to the MCE, the MCE is responsible for monitoring and controlling the air vehicle and payloads. It has the potential to control up to three air vehicles simultaneously, although sensor data would only be received from one air vehicle at a time. The MCE is the key control node that allows the system to provide the NRT information, which battlefield commanders need. The MCE's ability to dynamically re-task the air vehicle in flight, as well as change the sensors area of interest, supports this feature.

The MCE will be capable of passing "quick look" voice or tactical reports as necessary. The MCE receives data from the UAV via wide-band LOS or via commercial satellite, then processes the data and sends it to existing exploitation centers. Greater onboard processing capability will allow the data to be data linked directly to a theater processing site (Global Hawk only), the desired method. The MCE can store the image data for up to 24 hours, and can send selected stored data to a tactical requester (see Figures 3-8, and 3-9).

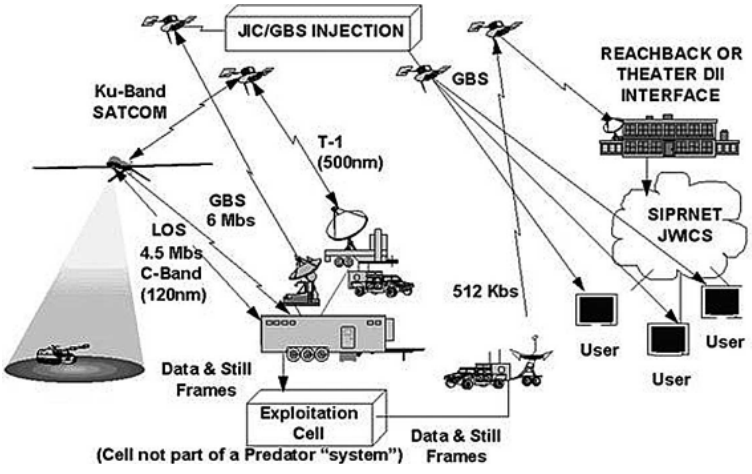


Figure 3-6: Notional Predator Mission Concept

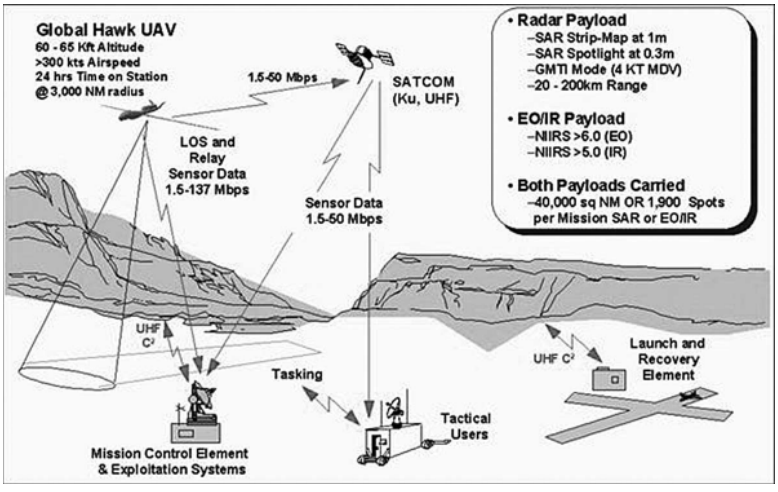


Figure 3-7: Notional Global Hawk Split-Site Concept

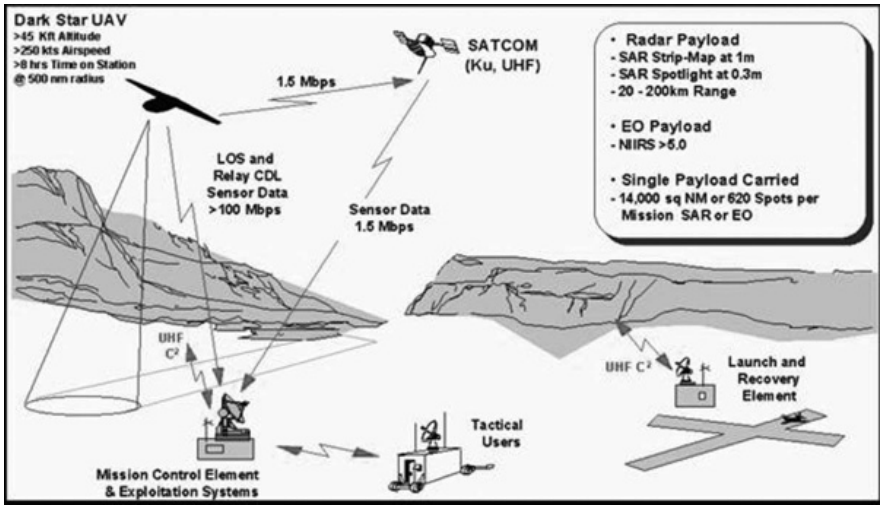


Figure 3-8: Notional DarkStar Split-Site Concept

3.6 THEATER AIR COMPONENT RESPONSIBILITIES

The following operational prerequisites and support services will be required from the receiving command to support UAV operations.

3.6.1 A theater concept of employment on how the theater plans to utilize UAV assets should be developed and include the following mandatory items:

3.6.1.1 Mission nickname.

3.6.1.2 Security classification and releasability.

3.6.1.3 Public affairs guidance.

3.6.1.4 General responsibilities of the air component command and subordinates.

3.6.1.5 Organizational responsibilities.

3.6.1.6 Operational reporting.

3.6.1.7 Mission track development.

3.6.1.8 Scheduling.

3.6.1.9 Execution and ATO integration.

3.6.1.10 Weather recall procedures and criteria for imagery missions.

3.6.1.11 Flight plan and theater ICAO and AWACS/ABCCC/JSTARS integration and deconfliction requirements.

3.6.1.12 Diplomatic clearance(s).

3.6.1.13 Collection area procedures to include sensor tasking/ employment.

3.6.1.14 Entry, departure, permissive and non-permissive airspace procedures.

3.6.1.15 Delay, re-launch, cancellation, and rescheduling notification procedures.

3.6.1.16 Equipment launch criteria.

3.6.1.17 Communications plan.

3.6.1.18 Recall and mandatory abort criteria and procedures.

3.6.1.19 Mission termination procedures.

3.6.1.20 Logistics, supply, and support issues.

3.6.1.21 Unplanned UAV retrieval procedures.

3.6.1.22 Unclassified operations mission statement.

3.6.1.23 Emergency airfield/landing area list (with confirmed GPS coordinates).

3.6.2 Other procedures and considerations for UAV integration into the theater include:

3.6.2.1 Request for and/or coordination of transportation of the UAV/ support package to and from the area of operations.

3.6.2.1 Cargo offload (onload) support, to include the capability to move the entire wheeled LRE, GCS, and/or MCE, GCS, spares, DarkStar air vehicles, payloads, etc., from the airfield to their operating locations (operating location to airfield).

3.6.2.3 Suitable improved runway for air vehicle launch and recovery operations of hard compact surface with a minimum of 5000 feet of runway length. Exact pre-surveyed coordinates for all primary and divert runways/ locations must be available to support the UAV's automatic takeoff and landing capability.

3.6.2.4 Aviation fuel for the air vehicles and diesel fuel for the support equipment.

3.6.2.5 Perimeter security for the UAV detachment.

3.6.2.6 Personnel support to include billeting, messing, and medical support if in a field operating environment.

3.6.2.7 Vehicle support for personnel, airframes, control vans and parts movement.

3.6.2.8 Access to logistical support network (military or commercial courier).

3.6.2.9 Access to the command and control architecture to include SATCOM use and coordination, as well as access to international telephone service.

3.6.2.10 Shelters for the deployed air vehicles.

3.6.2.11 Weather support is required for mission planning, launch criteria (local winds, target area, enroute and return weather and contrail forecast), landing weather (alternates).

3.7 AIR COMBAT COMMAND RESPONSIBILITIES ACC will provide support to the theater air component as required or requested to support UAV operations.

3.7.1 Provide support to theater air component as required or requested to support UAV operations.

3.7.2 Develop equipment security and unit classification requirements in coordination with theater air component commander, Joint Staff, and other agencies.

3.7.3 Deploy staff elements to support contingency, exercises, or special operations.

3.7.4 Assist theater air component commander in development of tracks and submit RECON 2 reports as requested.

3.7.5 Assist in development of Concepts of Operations (CONOPS) for specific theater operations.

3.7.6 Inform theater air component commander of UAV issues that may result in safety of flight restrictions.

3.7.7 Develop communications support plans in response to theater air component commander requirements for UAV interoperability and product dissemination.

3.8 ENVIRONMENTAL CONSIDERATIONS Endurance UAVs will be subject to weather considerations, including the impact of operating environment on both the systems reliability as well as air vehicle and sensor performance. Depending on the theater of operations, the ground operating environment for ground equipment and the air vehicles may challenge the safety of the air vehicle. Sand, salt air, severe temperatures or humidity may have adverse effects on the safe operations of the air vehicles. Long endurance operations at high altitude offer additional challenges that may affect safe air vehicle operations in-flight. Neither Predator or the HAE UAVs will have de-icing equipment (the Joint Program Office for Predator is currently managing an ice mitigation program involving an anti-ice system for the aircrafts wings);

while icing at normal Global Hawk or DarkStar operating altitudes is not common, coordination will be required to avoid areas of icing that could interfere with UAV control surfaces (icing may be encountered in climb or descent). Beyond visual range severe weather penetration by the UAV and clear air turbulence at altitude also pose safety challenges in terms of control of the air vehicle (see Paragraphs 2.4.10, 2.5.6, and 2.6.5).

3.9 AIR TASKING ORDER (ATO) PROCESS The means for implementing endurance UAV mission support is the ATO. The ATO will include the endurance UAV employment plan. The JFACC tasks the endurance UAV sorties through the ATO to accomplish specific missions and to provide sufficient data and detail to enable the joint forces to execute other RSTA missions. The support element must be capable of generating the mission plan within the time constraints of the ATO cycle. The AOC issues the ATO which is valid for a specified period. The AOCs Combat Plans Division will determine the endurance UAV orbit location based on prioritized coverage requirements, communications connectivity with supported units, and survivability considerations. While the ATO itself covers a specific period, the ATO planning, coordination, and execution process is continuous, much like land force planning. Due to the endurance characteristic (>24 hours) of these UAVs, a single endurance UAV mission may cross several ATO cycles. (See Section 5 for collection management and tasking.)

3.9.1 The effective and efficient use of endurance UAVs will require coordination and consultation between the AOC and multi-service/coalition liaisons within the AOC. This coordination is essential to ensure endurance UAVs are used where and when they will add most to synchronized battlefield operations. Additionally, the role (reconnaissance/surveillance/ targeting) that the individual UAVs will operate in will be determined by the JFC campaign plan. UAV operations will be planned and executed with emphasis on the phase of the campaign which will in turn drive the specific roles. As a result, the primary force management planner will shift between the J-2 and the J-3, with the JFACC as the focal point for integrating/synchronizing UAV capabilities to provide a maximum air effort for JFC's campaign plan. Joint combat operations will normally be planned in accordance with theater specific operational procedures.

3.9.2 Direct Support Direct support missions require supported commanders to determine their required coverage area, effective employment times of coverage, and sensor priorities. These requirements (including requests

for Wide Area Surveillance and other imagery products) will be preplanned, with the requests being forwarded by supported elements through the normal collection management process.

3.9.3 Liaison Requirements An endurance UAV liaison will be available to the AOC. Liaison responsibilities include:

3.9.3.1 Advise supported commanders of the systems roles, capabilities, and limitations.

3.9.3.2 Monitor mission execution to ensure it supports tasking.

3.9.3.3 Assist in dissemination of UAV derived data.

3.9.3.4 UAV planning.

3.9.4 Mission Changes/Dynamic Re-tasking During mission execution, commander(s) or unit(s) being supported by endurance UAVs may request changes in coverage area and times (see Section 5.3.2, Ad Hoc Tasking). Changes that require modification of the established orbit must be coordinated with the appropriate air space management, air defense elements (ADE). The Theater Air Control System (TACS) serves as the framework to ensure proper command and coordination lines between the Joint customers of UAV systems.

3.10 AIRSPACE MANAGEMENT AND DE-CONFLICTION The UAV Detachment Commander is directly responsible for the safe operation of the platforms under his control. He is responsible for liaison with local and regional air traffic control authorities to develop standard operating procedures that ensure appropriate de-confliction and adequate margins of safety. He is also responsible for establishing appropriate integration and de-confliction of air operations of his platforms in each AOR that the platforms are expected to operate. This includes integration into deployed local base procedures, local air base defense procedures, coordination with theater Airspace Control Authority (ACA) and integration into the theater Air Tasking Order (ATO). The GCS, LRE, PLRE, and MCE will have an interface with Air Traffic Control (ATC) authorities, and the air vehicle will be fully capable of operating in Federal Aviation Administration/ International Civil Aircraft Organization (FAA/ ICAO) controlled airspace under Instrument Flight Rules (IFR). The Global Hawk system is equipped to provide direct (LOS or relayed through the UAV) VHF/UHF communications between the air traffic controller and the UAV controller, in such a manner that the location of the UAV operator is transparent to ATC, without abnormal delays, and without special communication procedures in the ATC system. The Predator and DarkStar do not have any

voice relay capability; all communications from the GCS/LRE/MCE to authorities beyond LOS will be made through ground telecommunications. The air vehicles will navigate via waypoints using GPS, with navigation accuracy consistent with IFR requirements. All air vehicles have built-in redundancy and predictable autonomous contingency modes of flight, allowing safe operations in the event of system failures. The HAE UAVs have IFF with modes III, C, and IV (Predator does not have mode IV) to assist with air traffic de-confliction in peacetime and wartime. IFR flight will be required when operating outside of exclusive use airspace because of the air vehicle operating regime and the lack of "see-and-avoid" capability required for Visual Flight Rules (VFR) flight. Accordingly, it is envisioned that IFR vertical and horizontal flight separation from other aircraft, both in civil and special use airspace, will be required at all times; additionally, some form of exclusive use airspace may be required for launch and recovery operations.

3.10.1 Airspace Integration The issue of integration of UAVs into FAA/ICAO procedures is currently being addressed by the Air Traffic Controllers Association, including air vehicle design criteria, maintenance, operator training and certification requirements, and UAV operations within the National Airspace System (NAS). Advisory Circulars specifying standardized procedures for UAV operations, maintenance, design, and training/certification have been drafted and submitted to the FAA for development of Special Federal Aviation Regulations (SFARs). At present, UAV operations within the NAS must operate either within a positive control environment (Class A airspace and restricted areas) or with a chase aircraft, ground observers, or primary radar to provide pseudo- "see-and-avoid" capability. These issues, although currently being addressed, have not yet been resolved.

3.11 SAFETY OF FLIGHT/FLIGHT TERMINATION The redundancy provided by the full duplex satellite command and control data link and the full duplex LOS data link should ensure adequate monitoring and control of the air vehicle is always available. However, the air vehicle will also have an automatic return to base recovery mode, as well as a non-explosive mission termination feature which will be programmed to prevent vehicle termination from occurring over densely populated areas utilizing fail safe procedures. These capabilities are provided for range safety and operational use to prevent the air vehicle from becoming a hazard or penetrating prohibited airspace should contact with control elements be lost or the air vehicle deviate from the programmed flight profile.

3.12 FORCE STRUCTURE In general, the Services require sufficient quantities of endurance UAVs to satisfy JCS contingency and theater/wartime requirements; to support training and exercises; and to provide for backup aircraft inventory (BAI)/attrition reserve vehicles. Total force structure is dependent on a number of factors, the greatest of which is determination of military utility.

3.12.1 Table 3-1 shows a notional baseline force structure for Predator and Global Hawk. One Predator orbit is supported by a complete Predator system. Predator's near-continuous coverage is dictated by system constraints and transit distances to the operating area. One Predator system can be employed continuously for 90 days. Global Hawk will support a single continuous orbit for 30 days without resupply or vehicle replacement with this force structure. The DarkStar force structure presented in Table 3-2 represents the recommended baseline for supporting one sortie per day for 30 days.

	On Orbit	In Transit	Standby (Alert)	BAI	Total
Predator (1 System/Orbit)	1	N/A	1	2	4
Global Hawk	1	1	1	1	4
DarkStar	1	0	1	1	3

Table 3-1: Predator and Global Hawk UAVs Required Per Orbit

	On Orbit	In Transit	Standby (Alert)	Spare	Total
DarkStar	1	0	1	1	3

Table 3-2: DarkStar UAVs Required For One Sortie Per Day

3.12.2 Endurance UAVs can be expected to contribute to all operational phases: peace, readiness, deployment, employment, sustainment, and redeployment. UAVs may find utility in complementing our current force enhancement assets in areas other than IMINT. Such uses may include: SIGINT, MASINT, laser designation, communication relay, data relay, electronic attack, counter insurgency, counter terrorism, aerial mapping, disaster

relief, psychological operations, nuclear strike damage assessment, special operations (strikes/raids, etc.) and arms control. In short, once the UAV mission requirement is defined force structure can be determined.

3.13 UAV MANPOWER As the various Advance Concept Technology Demonstrators come to fruition, ACC, as executing command, will have to include in its program objective memorandum (POM) for the operations and maintenance (O&M) to provide, train, equip, maintain, and fly the force structure. These actions assume the endurance UAVs prove to be operationally and militarily useful, and subsequently added to the Air Force inventory.

Gp Capt Murli Menon (Retd)

After his NDA and Air Force training Gp Capt Murli Menon (Retd) was commissioned into the fighter stream of the IAF in 1973. He has had a distinguished professional career in field and staff assignments spanning over three decades , including as a Directing Staff at IAF's Tactics and Combat Development Establishment (TACDE) and flying inspector with the Directorate of Air Staff Inspections (DASI). After commanding a MiG 23 MF fighter squadron at Adampur he was one of three officers specially selected to craft IAF's first ever Air Power Doctrine, the IAP 2000, at the Air War Strategy Cell in Air HQ. He was awarded a Presidential award Vayu Sena Medal in 1993 for this endeavor. He then went on to command a premier fighter base in South Western Air Command. He also served in key staff appointments in Air Defence and Intelligence directorates at Air HQ. He was part of the "Battle Staff "during the Kargil air operations. He served thereafter as India's Air Adviser at High Commission of India, Islamabad between 2000-2004, a period marked by paradigm shifts in the strategic landscape in the subcontinent post 9/11, in the Musharraf era. Moving laterally to the Cabinet Secretariat in 2004, he served there handling Pakistan/ China military desks and later as Consular at Ankara, Turkey between 2007-2011. On return from Turkey he looked after for two years training of midlevel intelligence operatives of the government. He now writes for some think tanks in India and the USA, besides also contributing to some Indian Defence journals and media houses.

The China Pakistan Economic Corridor

Gauging Implications for India's Claim on Pakistan occupied Kashmir

Dr Priyanka Singh

Introduction

The much anticipated China Pakistan Economic Corridor (CPEC) has been continuously steering the subcontinental strategic debate for a while. China is the centre of gravity in the ambitious CPEC project worth $ 46 billion that will be channelled in numerous infrastructure and hydropower projects across Pakistan. With China scaling burgeoning economic rise over the years, the project has galvanized the global discourse as well with a wide spectrum already intensely deliberating the potential prospects and impact of this coveted intercontinental connectivity project. Finally unveiled during Chinese President Xi Jinping's visit to Pakistan in April 2015, the CPEC is increasingly slated to be a project to reckon with- one that could potentially alter the geopolitics and geo-economics of the region.

Apart from this, since the unveiling, the project has been constantly referred with numerous metaphorical adjectives- notable among them being that the upcoming corridor could be somewhat a 'game changer' and a one-stop remedy for Pakistan's continuing economic distress and energy woes. Significantly, a major portion from the promised $46 billion (approximately $ 33 billion) will be invested in various ongoing and future projects in Pakistan's energy sector.

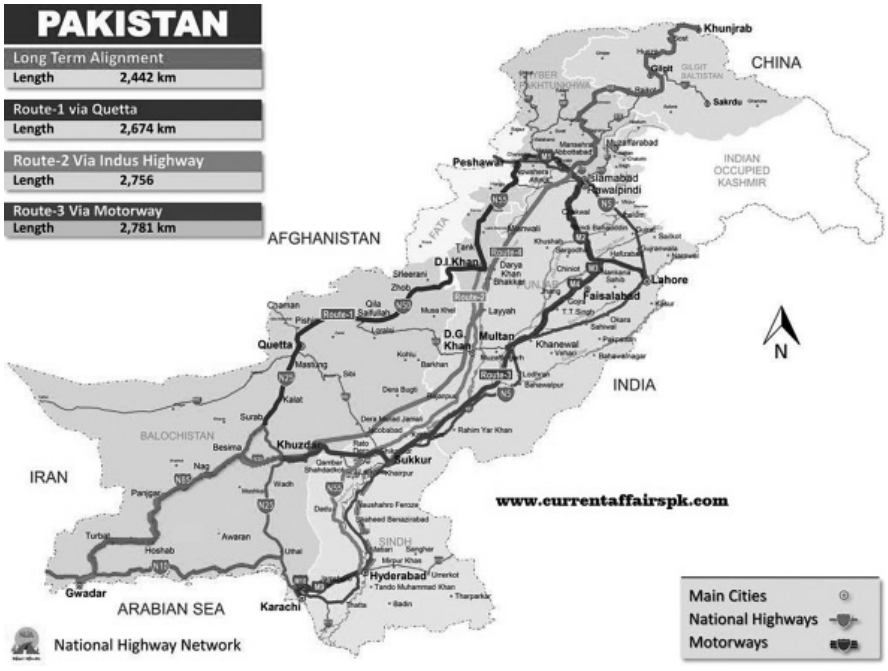
ISSN 2347-9191 print

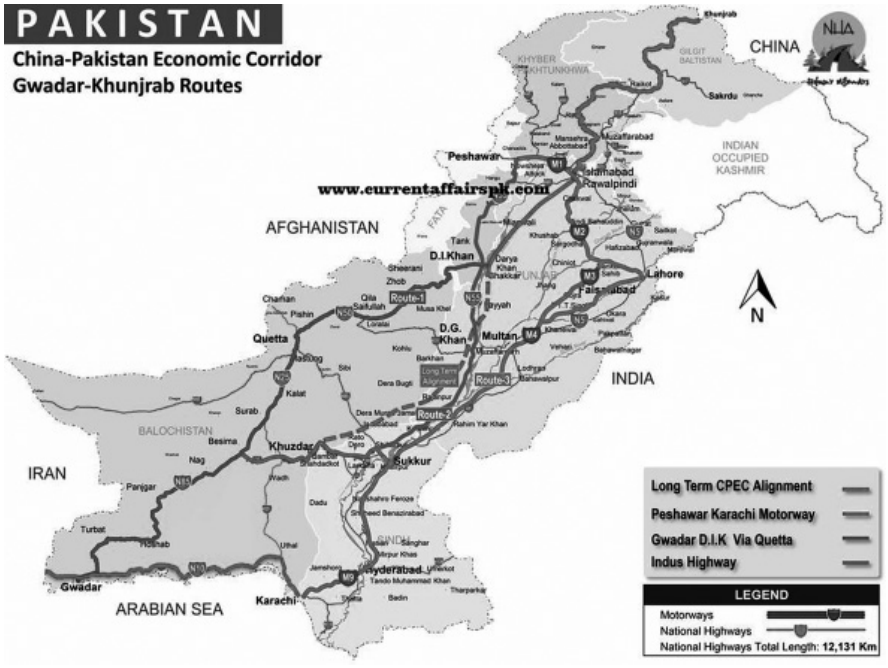
CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 133–144

To encapsulate, the comprehensive CPEC project design consists of a "clutch of major infrastructure works currently under way in Pakistan, intended to link Kashgar in China's Xinjiang province to Gwadar deep sea port close to Pakistan's border with Iran. Several other road, rail and power projects are associated with the corridor, and the project seeks to expand and upgrade infrastructure across the length and breadth of Pakistan, and to widen and deepen economic ties with its "all-weather friend", China."i

Routed across PoK

The CPEC will reach Pakistan mainland after cutting across Gilgit Baltistan region that originally belonged to the erstwhile princely state of Jammu and Kashmir and since India's partition, is part of Pakistan-occupied Kashmir (PoK). PoK refers to parts of the erstwhile princely state of Jammu and Kashmir (J&K) which have been under Pakistan's control since 1947. It currently comprises two administrative units- the so-called 'Azad' Jammu and Kashmir ('AJK') and Gilgit Baltistan, which until 2009 was referred to as the Northern Areas by the government of Pakistan. PoK is legally claimed by India by virtue of the Instrument of Accession signed in India's favour by the ruler of Kashmir, Maharaja Hari Singh on 26 October 1947 and the Parliamentary resolution of which yet again reiterated India's claim and position on these areas.





From being the most volatile issue of contention between India and Pakistan, the Kashmir issue has perennially been under the shadow of the Peoples Republic of China, the mighty nation that shares a strong bonhomie with Pakistan. Notably, China over the years developed considerable stakes in the resolution of Kashmir issue. Most importantly, China is in possession of a substantial chunk of territory which belonged to the erstwhile princely state of Jammu and Kashmir- i.e. the Aksai Chin area and the Trans-Karakoram Tract (Shaksgam Valley) that was ceded to China by Pakistan in 1963 in the aftermath of India-China war of 1962.

The territorial swap between the countries stemmed from the Sino-Pak border agreement inked in 1963 as a provisional border arrangement (pending the ultimate solution of the Kashmir issue). Apart from the fact that China got control over Trans Karakorum tract lining the strategically significant territories under its control, Pakistan too, is known to have got some territory in exchange. In the wake of the Sino-Pak Border Agreement, India led a vociferous diplomatic and political protest again the arbitrary step undertaken by the two countries in total disregard of India's long standing claim on PoK as part of the erstwhile princely state of J&K. As noted, in October 1947, the ruler

of princely state, Maharaja Hari Singh signed an Instrument of Accession in India's favour. In many sense, the ghost of 1963 seem to have revisited yet again with the unveiling of the whopping $ 46 billion worth CPEC that will raise massive infrastructure within Pakistan, after having cut across the only land link between Pakistan and China- Gilgit Baltistan.

In this backdrop, this article attempts to examine the long term and short term implications of the forthcoming CPEC project for India's extant claim on PoK. China's growing forays into PoK, especially Gilgit Baltistan, have been much reported and discussed, including in the strategic circles within India. Such discussions were flared by sporadic reports of China building extensive infrastructure and hydropower projects in PoK. Of late, the nature and scope of Chinese involvement in PoK has also inspired widespread academic interest and commentary in the west. With the announcement of the multibillion CPEC, the proportion of strategic complexities for India is likely to compound. Such prospects necessitate that India braces itself for potential contingencies and arm itself with pertinent policy measures to deal with what some could call an impending crisis- likely outcomes as China relentlessly continues to strengthen its control and stakes over PoK.

Was the CPEC seeded in Sino-Pak Border Agreement 1963?

The genesis of China-Pakistan collusion in PoK can be traced to the India China conflict 1962 as India was rendered effectively weak in the aftermath of the war. Sino-Pak border agreement was conceived at a ripe moment in 1963 based on vice considerations that India will not be in a positon to lodge a consequential protest against an agreement inked on a territory claimed by it and traded between others. However, India did take up the issue by lodging a forceful protest against the agreement and conveyed its opposition on the same in a separate letter of protest to China. China, on its part, continued to emphasise the provisional nature of the agreement that was incumbent on the final resolution of the Kashmir issue-a bilateral problem between India and Pakistan.

Meanwhile, India took exception the agreement and launched a diplomatic offensive challenging the validity of the border agreement between Pakistan and China. The then Defence Minister of India, V Krishna Menon, deftly articulated India objections on the development on May 10, 1962 noting: "Pakistan merely for nuisance value and as an instrument to put pressure on us-has entered into negotiations and concluded agreement with the Central

Government of Peoples' Republic of China. That agreement is in total violation of any rights or authority Pakistan may possess, for it has no sovereignty over this state; it is not Pakistan's to trade away or negotiate about. It has been done on a basis which we cannot accept- our position in regard to China, which is not under discussion before the Security Council".ii

Citing the illegitimacy of any agreement that involved a territory which belong to the erstwhile princely state, India condemned the China-Pak bid to undertake a unilateral and arbitrary decision of concluding a boundary settlement/understanding on a contested territory. In a letter of protest to China, India's critical position was clearly delineated. The letter noted amongst other things: "In lodging an emphatic protest with the government of the Peoples Republic of China for this interference with the sovereignty of India over the state of Jammu and Kashmir, the government of India solemnly warns the government of China that any change, provisional or otherwise, in the status of the state of Jammu and Kashmir bought about by their parties which seek to submit certain parts of Indian territory to foreign jurisdiction will not be binding on the government of India and that the government of India firmly repudiate any agreements, provisional or otherwise, regarding her own territories arrived at between third parties who have no legal or constitutional *locus standi* of any kind".iii

China responded on May 31, 1962 by noting its wariness over the unresolved issue by stating that: "More than ten years have passed and despite the best wishes and expectations cherished by China, this dispute between India and Pakistan remains unsettled. In this circumstance, any one with common sense can understand that the Chinese government cannot leave unsettled indefinitely its boundary of several hundred kilometres with the areas the defence of which is under the control of Pakistan over Kashmir. It is entirely necessary, proper, legitimate, and in accordance with the international practice for the Chinese government to agree with the government of Pakistan to negotiate a provisional agreement concerning this boundary pending a final settlement of the Kashmir question".iv

It is believed that the Sino-Pak border agreement and the transfer of crucial control over the Trans-Karakoram Tract to China was an advance pay off for the subsequent building of the Karakoram Highway conceived closely in the aftermath of the agreement. In due course the building of the Karakoram Highway proved a milestone in the effervescing and flourishing China-Pakistan ties. The highway was built across Gilgit Baltistan before navigating inside

parts of Pakistan. The highway is the highest mettle road built on a daunting geographical terrain and serves as the vital land link between the two countries. Over the years the highway has evolved as a viable means to ferry goods across the two sides. Harsh geographical and ecological realities stare the Karakoram highway which has been persistently inhibited by the weather extremities remaining closed during long winter months. However, this does not undermine the extreme strategic significance of this pivotal road link, a symbol of growing bonhomie and robust cooperation between the two 'all weather allies'.

Connecting such wide historical dots, it can be concluded that the CPEC in all likeliness, as envisaged today, seems to be the grand culmination of a strategic partnership, the foundation stone for which was laid in the form of a provisional agreement, long before this project in particular was set in motion. On legal terms, the Sino-Pak border agreement still stands provisional/temporary as the Kashmir issue is yet to be resolved. The clause of intermittence was attached to the agreement by the two sides-China and Pakistan pending future resolution of the Kashmir issue and thereby tying the future of the agreement to the terms and nature of settlement.

Thus, Chinese efforts and strategy behind funnelling billions of dollars in the CPEC project that is slated to be based on a temporary set of principles and informal understanding between the two sides, is neither fully comprehensible nor self-apparent. Chinese haste could be partially attributed to its wider geopolitical compulsions of enabling a direct and safe passage to reach the strategic end point at the Gwadar Port in Balochistan (the warm water port is already administered by the Chinese). The core thinking behind the Chinese urge to touch the Arabian Sea directly via PoK and Pakistan is linked to the Malacca dilemma, oft cited as one of the biggest perceptible threat assessment for China as the major chunk of China's oil supplies are ferried through this route (seen as an area under threat from India's navy).

CPEC unimaginable without Gilgit Baltistan

Gilgit Baltistan as the only land link between China and Pakistan is critical to a connectivity network project such as the CPEC. In every sense, a land connectivity network project such as the CPEC cannot dispense with Gilgit Baltistan. Hence, it is nearly impossible to imagine an expansive land connectivity project CPEC which involves sprawling infrastructure and hydro-power projects without the existence of Gilgit Baltistan, more significantly, under Pakistan's control. Contrary to this, what has become increasingly becoming apparent is

that the inevitability of Gilgit Baltistan to the CPEC has remained completely eclipsed in the emerging discourse on the project, especially within Pakistan. The CPEC discourse is loaded with metaphorical references showcasing the grandiosity of the project as a harbinger of development and prosperity for the country. On the other side, it is rarely that Gilgit Baltistan has featured prominently in debates concerning CPEC in a meaningful way.

Gilgit Baltistan is a region located at the heart of Asia blessed with huge connectivity potential straddling important countries of the region. Lack of acknowledgement of the indispensability of Gilgit Baltistan to the CPEC on the one hand and failure to engage the local people or their representatives in any of the processes dealing with the CPEC on the other, has heightened concerns and accentuated the long prevailing sense of neglect and alienation in the region.

India's emerging stance on CPEC

India's broader positon on the CPEC hinges on the fact that it is going to cross through a region which falls under its territorial claim on PoK as part of the larger problem of Kashmir. The CPEC has been on the anvil for a long time- previously referred to as the Karakorum corridor. All these years, while India's official stance on PoK remain infrangible, the issue of the possibility of an economic-cum-strategic China Pakistan joint corridor did not find relevant traction in the domestic circles. This was partially due to the fact that the Karakoram Highway has been in place for several decades and China's increasing involvement in the PoK region per se was a given. Hence, in many ways, the enormity, nature and scale of the CPEC project was realised and mooted over only after a whopping sum of $ 46 billion was attached to it. The sheer volume of the CPEC budget evoked varied reactions in India- ranging from alarmism, alacrity to the more balanced and measured ones. The alarmist propositions on the CPEC posit that it is quintessential to take into account the monetary contrast between the CPEC and previous Chinese investment both in Pakistan and PoK. Accordingly, it would be naïve to perceive the grander CPEC in the same stride and somewhat equate them recurrent instances of Chinese aided infrastructure and hydropower projects either in Pakistan or PoK in particular.

While Indian government have issued episodic statements on Chinese ingress in PoK, such proclamations have been far from making any meaningful impact on the pursued intent of either China or Pakistan. India's officials statement on issues related to PoK have neither been detailed and seem to

lack necessary robustness and rigour on issues involving significantly errant neighbour/adversaries as Pakistan and China. Initially, India has not been quite so forthcoming in voicing its concerns on the CPEC- both territorial and strategic. It was only after the CPEC reached its formal stages of announcement that statements raising concerns on the unwarranted nature of the project came to the fore from the Indian side. Back in December 2014, a query was raised in the lower house of the Parliament on the issue. India's Minister for External Affairs, Sushma Swaraj, responded to the concerns noting: "Government has seen reports with regard to China and Pakistan being involved in infrastructure building activities in Pakistan Occupied Kashmir (POK), including construction of China-Pakistan Economic Corridor. Government has conveyed its concerns to China about their activities in Pakistan Occupied Kashmir, and asked them to cease such activities.v

Later in May 2015, amidst Prime Minister Narendra Modi's high profile visit to China, there were widespread reports that the Indian objections towards the upcoming strategic corridor have been taken up at the highest level in his meeting with the Chinese President Xi Jinping. This was soon endorsed by India's Foreign Secretary S. Jaishankar who noted: "India has lodged a protest with China over its plans to invest $46 billion into a proposed Pakistani economic corridor that passes through Kashmir". vi Hence, during 2015 one could witness shoring up of a certain policy opinion on the CPEC inside the country aided by some high voltage television debate and press writings on the subject. The finer nuances of a comprehensive and streamlined approach towards the CPEC and a detailed policy stance still seems to be evolving gradually towards taking a more concrete shape.

Concurrently, the public discourse on CPEC in India is slowly taking shape with few deviances and conflicting signals still showing up in this particular domain. Part of the problem is the fact that PoK as a subject of serious debate has hardly figured either in public, academic or television discussions. Unless the causative factors are taken in account, i.e. what is the principal driver behind a particular stand on an issue such as the CPEC, a cohesive, substantial thinking or perception on the CPEC cannot be hoped to achieve in near future.

Reading India's claim on PoK vis a vis CPEC

What lies at the core of the Chinese objectives, which it hopes to realise vis a vis the CPEC is an unfettered access to the Persian Gulf via the Gwadar port in Pakistan situated on the Arabian Sea. This route would proffer the Chinese

a viable and assured alternate to the Malacca route which under the Chinese geo-strategic calculus, continues to be vulnerable to constant threat from India's naval prowess. In terms of the key ultimate goals, the CPEC project seems to be propelled by perceived threat from India based on future projections regarding India's possible recourses in situation of war.

With the CPEC, the Chinese stake are bound to multiply not only in Pakistan, but more significantly from India's point of view, in a much bigger proportion into the PoK region as well. As India's position on the entire state of J&K continues to be governed by the Instrument of Accession and the Parliamentary Resolution of 1994 (both clearly delineates that the whole state of J&K is an integral part of the Indian Union), the CPEC as the latest re-embodiment of the China Pakistan nexus in PoK, comes across as a serious strategic challenge, where both countries yet again appear to be grossly tinkering with India's overall sensitivities.

Implications for India: compounding challenges

The CPEC if fructifies as planned by China in partnership with Pakistan is abound with mammoth strategic challenge for India, both in near and long term view. First and foremost, it will further undermine and dilute India's standing claim on the PoK. Before the advent of the Chinese into the Kashmir problem, India officially dealt with a singular adversary on the issue, i.e. Pakistan. As John W. Garver notes: "China has stood quietly but effectively behind Pakistan during periods of Pakistan-India conflict over Kashmir".vii This element of tacit Chinese support to Pakistan under the garb of a neutral official positon to Pakistan on Kashmir may progressively transform into a more pronounced backing underpinned by the huge quantum of investment being made in Pakistan through the CPEC.

India's overall position on PoK has been rather muted since 1947. In the years after independence, this was mainly due to the Cold War dynamics in a realm dictated by power blocs and when India chose to chart an independent nonaligned course. The roots of India's policy inertia on PoK could be traced to such historical complexities prevalent in the international relations then. What is however disconcerting to note is that Indian stance on PoK has not evolved much positively even as India has continued to grow in political and economic stature, especially since the end of Cold War. The Parliament resolution on 1994 categorially called upon that: "Pakistan must vacate the areas of the Indian State of Jammu and Kashmir, which they have occupied through aggression".viii The

resolution further expressed: "regret and concern at the pitiable conditions and violations of human rights and denial of democratic freedoms of the people in those areas of the Indian State of Jammu and Kashmir, which are under the illegal occupation of Pakistan".ix The strongly worded resolution provided a strong impetus to reset the India policy posturing on PoK at that point. It seems however that the resolution failed to capitalize its optimal potential in due course in terms of reversing the inertia in India's approach towards PoK. Nevertheless, in subsequent years the Parliamentary resolution on Kashmir became a strong point of reference and source of abidance to substantiate India's official stance on PoK.

Similarly opportune moment from India's point of view regarding PoK were ushered in post 2005 earthquake- an unprecedented ecological calamity which caused colossal destruction in entire PoK including Gilgit Baltistan (parts of north India including J&K were also hit). A number of international reports narrating the dismal situation in parts of PoK were published during this period. These reports ably documented the existence of widespread poverty, lack of infrastructure and development in the entire PoK. Notable amongst these were Emma Nicholson's report, the report on Human rights violations in the so called Azad Jammu and Kashmir aptly titled *With friends like these, who needs enemies* and reports by the International Crisis Group (ICG) on Gilgit Baltistan (then referred to as the Northern Areas) made certain startling revelations on the depressing state of affairs prevailing in PoK.

Political implications

With the Chinese dimension getting intensified, India will find it incrementally difficult to deal/bargain with Pakistan on J&K in general, and PoK in particular. Though a series of contradictions have been witnessed in the Chinese policy on Kashmir despite a stated neutral position that Kashmir is a bilateral issue between India and Pakistan, the Chinese look little wary of the fact that the crucial arterial links of CPEC cut across a contested region. Chinese on their part seem rest assured regarding the territorial hassles between India and Pakistan and seem to be moving steadfast towards realising CPEC, part of a calculated agenda in China's expansionist strategy that would enhance its intercontinental access to vast swathes of potentially lucrative markets for domestically manufactured Chinese goods.

Strategic implications

Since early 2000s, there has been a debate on the perceptible Chinese design to encircle India. In this regard, the String of Pearls theory has been extensively debated and frequently cited in the strategic discussions. In the emerging context, one is witnessing an unfurling of a series of Chinese led infrastructure projects in India's neighbourhood, (some of them considerably high end projects). Projects as enormous as the CPEC in the vicinity of India's periphery, especially through a territory claimed by it, underscores the possibility or attempt to India getting boxed in a limited geopolitical sphere- overshadowed by the massive China-Pakistan economic engagement that would only increase monumentally with the fruition of the CPEC.

Economic challenges

Apart from the more serious challenges as mentioned above, India's policy on PoK in sync with its overall position on J&K needs to be cognizant of the possible economic boom which the CPEC could usher in on the other side across the Line of Control (LoC) and brace itself with mechanisms and relevant venues in order to channelize similar economic aspirations on this side of the LoC.

Options for India

India needs to proactively think in term of niching out a carefully thought and well-oiled strategy, both in medium and long terms to tackle foreseeable challenges from the China-Pakistan partnership- that is at play in a region involving India's extant territorial claims. To begin with, India needs to scale up policy pronouncement on PoK. There are several way of doing so. Most effective method in this regard would be to punctuate the legal claim on PoK as and when a related matter is under consideration. It needs to be understood that without reinforcing its policy on PoK, India cannot effectively present its case of opposition/objections towards the CPEC.

Similarly, all issues concerning PoK should be inserted in India's bilateral agenda with both Pakistan and China. Though China may keep harping on the conventional line that Kashmir is bilateral issue between India and Pakistan, reality is, China has deliberately got into the tangle in dubious ways. Therefore, India has no option but to discuss and question China, as and when necessary, on its purported objectives and ongoing activities in both parts of PoK.

Lastly, India must also think of ways to muster international opinion against the CPEC being built through a disputed region, claimed by India since 1947. With China's errant behaviour in dealing with a host of countries in the region, there are high prospects that India opposition to the CPEC may find necessary traction amongst most states.

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China's White Paper on Xinjiang: Some Reflections

Dr Avinash Godbole

The Information Office of the State Council of the People's Republic of China recently published a White Paper on Xinjiang titled Freedom of Religious Belief in Xinjiang.[1] This paper follows the previous White Paper Historical Witness to Ethnic Equality, Unity and Development in Xinjiang, published in September 2015.[2] This is for the first time that two white papers on Xinjiang have followed one another so quickly. Moreover, earlier in April 2016, China also held its national conference on religion and it can be seen that the recent white paper follows the tone of the conference.[3]

Localisation of religion and avoidance of dispute are the central ideas that the White Paper is promoting and these were also the themes at the China's national conference on religion. The White Paper's conclusion is crystal clear in that sense as it argues. "China, based on its national conditions, sticks to the principle of independence and self-management of religious undertakings, and will never allow any foreign organization or individual to interfere with China's

1 Information Office of the State Council, "Freedom of Religious Belief in Xinjiang", White Paper issued on 2 June 2016 at http://www.scio.gov.cn/32618/Document/1479266/1479266.htm (accessed 3 June 2016).

2 Information Office of the State Council, "Historical Witness to Ethnic Equality, Unity and Development in Xinjiang", White Paper issued on 24 September 2015, at http://www.china.org.cn/government/whitepaper/node_7230328.htm (accessed 12 June 2016).

3 http://news.xinhuanet.com/english/2016-04/23/c_135306131.htm

ISSN 2347-9191 print

CASS Journal, Vol. 3, No. 3, July-September 2016, pp. 145–150

religious affairs."[4] The 2016 white paper's broad conclusion is that "History has proved that the existence and development of religions must be adapted to society and follow the path of localization; the coexistence and integration of religions must be achieved through inclusiveness, mutual learning and harmony; and the freedom of religious belief can only be obtained by keeping religious wars and conflicts at bay."[5]

There is also a curious way in which the white paper looks at the relationship between state, society and religion. It says, "Xinjiang takes active measures to make religions to adapt to socialist society, and prevents the use of religion in interfering in the administrative, judicial, educational and other social affairs." Thus, religion that has to adapt itself to the realities of the socialist state, according to the white paper. Section one of the white paper argues, "A religion should adapt itself to the times and human environment, and achieve localization, so that it can continue. History shows that wars between different religions and disputes between different sects of the same religion deprive people of the free choice of religion."

President Xi Jinping's speech during the April 2016 conference on religions stressed that the party's policy was based on "religious freedom, manage religious affairs in line with laws, retain the principle of religious independence and self-administration, and help religions adapt to the socialist society".[6] Another quote of Xi Jinping that was widely cited in the media was "We must resolutely guard against overseas infiltrations via religious means and prevent ideological infringement by extremists".[7]

One general interpretation that can be made from these two white papers is that China is willing to allow diversity only as long as it falls within the Chinese institutional framework that the party has for so long propagated. For example, in the 2015 white paper, it is argued, "Known for their hard working,

4 Op cit. No. 1.

5 Op. Cit. No 1.

6 Xinhua, "Xi calls for improved religious work", China.org.cn, 24 April 2016, at http://www.china.org.cn/china/2016-04/24/content_38312410.htm (accessed 9 June 2016). Also see, Xu Wei, "Govt line on religions wins support from faith leaders", China Daily, 25 April 2016, at http://www.chinadaily.com.cn/china/2016-04/25/content_24804800.htm (accessed 9 June 2016).

7 PTI, "People of all faiths should not challenge the CPC leadership: Xi", Business Standard, 24 April 2016, at http://www.business-standard.com/article/pti-stories/people-of-all-faiths-shouldn-t-challenge-cpc-leadership-xi-116042400392_1.html (accessed 8 June 2016).

wisdom and bravery, the ethnic groups of Xinjiang created a distinctive multiethnic culture, which became an important part of overall Chinese culture".[8] While looking at ethnic diversity in China, the white paper is focussed on showing the Chinese characteristic of Xinjiang. If the chapter titled *Implementing the System of Ethnic Regional Autonomy* starts with such a disclaimer, then it becomes clear that the scope of autonomy is limited.

A section of Xinjiang population has adapted violent methods in the recent past. It is a well known fact that local ethnic identity in Xinjiang has assumed a political dimension after the creation of ethnic nation-states in Central Asia after the collapse of the Soviet Union. Some of the Uighurs have raised their stakes in creation of an independent country called East Turkestan. The year 2014, in particular, was the most violent year as the maximum number of deaths, nearly 400, in terrorist incidents was reported in that year. A few ethnic Uighurs from Xinjiang have also joined the Islamic State in Syria. An article in the Global Times estimated this number to be 300.[9] In addition, killing of a Chinese national by the Islamic State in November 2015 had also triggered angry reactions on the Chinese social network sites. The white paper's approach to extremism in Xinjiang is that religious extremism comes from outside and does not have any domestic root. It says, "Affected by international religious extremism, religious extremism has grown and spread in Xinjiang in recent years."[10]

Another development, which China blames on external factors, is the increased Arabisation of Xinjiang; for example there was a definitive increase in the number of women using burqa in Xinjiang in the last one decade. In December 2014, authorities in Xinjiang had banned the use of burqa in public places in Urumqi, calling it "non-local attire". This move, seen as one limiting local people's freedom of choice, was responded to by a sizable number of protests. Xinjiang courts have also ruled against beards and in one peculiar judgement had give a Uighur national 2 years imprisonment for not shaving his beard and for not allowing his wife to not use burqa in public places. He was charged with "making others wear extrem-

8 Op. cit., no 2.

9 Zhang Yan, "Turkey to Help in Foiling Suspects from Xinjiang", China Daily, January 15, 2015, at http://www.chinadaily.com.cn/world/2015-01/15/content_19322236.htm Accessed 12 June 2016.

10 Op Sit, no. 1.

ist clothing".[11] At the same time, burqa while being non-Uighur in origin, also represents a substantive challenge to the Chinese State's assimilationist project in Xinjiang. China's push for assimilation is creating a new kind of Uighur identity. However, as the recent white paper shows, China is pushing for greater assimilation as a response to the challenge in Xinjiang. Segregation of dining places based on whether or not they served pork is another new trend seen in Xinjiang of the 21st century.[12]

The white paper is also consistent with the principles enshrined in the Constitution of the PRC. Article 36 of the Constitution of the People's Republic of China clearly stipulates: "Citizens of the People's Republic of China enjoy freedom of religious belief." "No state organ, public organization or individual may compel citizens to believe in, or not believe in, any religion; nor may they discriminate against citizens who believe in, or do not believe in, any religion." "The state protects normal religious activities. No one may make use of religion to engage in activities that disrupt public order, impair the health of citizens or interfere with the educational system of the state. Religious bodies and religious affairs are not subject to any foreign domination."[13]

Overenthusiastic interpretation of this constitutional provision is the reason why certain counties and prefectures in Xinjiang issue advisories on the subject of Ramazan fasting by teachers, students and officials and certain others issue notes and memos to "eat well and stay healthy" and still few others distribute fruits and juices during daytime. Reports of such bans have been doing rounds, in particular since 2013. In 2016, media has reported that a party website had issued an advisory at the beginning of Ramazan Party members, cadres, civil servants, students and minors must not fast for Ramazan and must not take part in religious activities," and that "During the month of Ramazan, food and drink businesses must not close".[14] Such

11 Li Rouhan, "Court names new extremism-related crimes", *Global Times,* 2 November 2015 at http://www.globaltimes.cn/content/950232.shtml (accessed 14 June 2016).

12 Ziad Haider, "Sino Pakistan Relations and Xinjiang's Uighurs: Politics, Trade and Islam along the Karakoram Highway", Asian Survey, XLV (4), p. 527.

13 National People's Congress of the People's Republic of China, "Constitution of the People's Republic of China, Chapeter III: The Fundamental Rights and Duties of the Citizen", at http://www.npc.gov.cn/englishnpc/Constitution/2007-11/15/content_1372964.htm (accessed 12 June 2016)

14 AFP, "China imposes customary ban on civil servants, students from fasting during

advisories get issued in departmental or municipal council websites. This year, Korla and Khorghos city websites had such advisories. The Xinjiang provincial administration has denied issuing such advisories.

Therefore, there is no provincial ban on observance of Ramazan in Xinjiang; however, there is an active discouraging of the policy of fasting among a certain group of people. In particular, focus has been given to the youth below the age of 18 as far as advisories during Ramazan. China's fears of spread of radicalisation and terrorism are behind such advisories that get issued regularly. The government's unstated interpretation is that since the observance of Ramazan in voluntary, underage youth should be given adequate knowledge and choice before they begin the practice of fasting.

In the 21st century, the rise of Chinese nationalism has been based on the foundation of China's rise being a response to the century of humiliation and victimhood at the hands of colonial powers. That is the kind of discourse China has also advanced on its position on all of its territorial and national security disputes on Taiwan, on Xinjiang and on South China Sea China.[15] The victimhood concept is about China as a peacefully developing country that is challenged by external forces. The same discourse in seen to be advanced in case of Xinjiang and its extremist challenge as seen in case of the present white paper. China took its domestic anti-extremism clampdown a step further by using the global war on terrorism discourse in the aftermath of 9/11, especially in getting certain organisations banned globally. There was a perception that China had overstated Xinjiang's links with the extremist networks outside. The present white paper shows that it has come full circle. Now it seeks to further limit the foreign influence in interpretation of religion and religious freedom in Xinjiang.

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14 Ramadan", Indian Express, 6 June 2016 at http://*indianexpress.com*/article/world/world-news/china-imposes-customary-ban-on-civil-servants-students-from-fasting-during-ramadan-2838128/ (accessed 12 June 2016).

15 See for example, Andrew Browne, "The Danger of China's Victim Mentality", *Wall Street Journal,* 14 June 2016, at http://www.wsj.com/articles/the-danger-of-chinas-victim-mentality-1465880577 (accessed 14 June 2016).

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