# IAF Equipment and Force Structure Requirements to Meet External Threats, 2032

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*In keeping with the theme 'IAF Deep Multidimensional Change 2032: Imperatives and a Roadmap', this article focuses on the responses to the external threat challenges that are likely to be face by IAF in 2032. These external challenges have been identified to be the individual Chinese and Pakistani threats as well as a combined Sino-Pak threat. The article confines itself to developing a possible force structure only in terms of numbers of combat and support aircraft of various types for 2032. It contains an examination of the currently planned IAF structure for the year 2022 and beyond, against the war-gamed force requirement for winning wars along our borders while retaining capability to project force in areas of national interest beyond our borders. The article underscores the fact that the current plan for the force structure requires to be enhanced to meet the challenges successfully.*

## Introduction

This article follows 'Challenges for the Indian Air Force: 2032' (Vol. 7, No. 1, January-March 2013), dealing with the main challenges Indian Air Force (IAF) is likely to face in 2032, when it completes a century. Here, I assess possible responses to the external challenges posed by the Peoples Liberation Army Air Force (PLAAF) and Pakistan Air Force (PAF). I do so separately in a single-front war scenario against either one and follow it up with a worst case scenario of a simultaneous war against both. I begin

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with explaining the method of working out force level requirements, followed by the working out of required force levels for a one-front border war. I follow this up with an expansion of this force level calculation to cover a two/two-and-a-half front war situation. The article culminates in a suggested force structure for the 2032 time period in order for the IAF to meet all its expected commitments effectively.

## Future Force-level Projection Methodology

The first possible method of calculating force-level requirements is to work on units of force per unit of border length. While it may be feasible for land forces, it is unsuitable for air forces due to the fact that an aircraft or a squadron of fighter–bombers cannot be assigned to, say, x km along the border as they are able to reach much larger distances laterally as well as longitudinally. Moreover, the lack of persistence[1] of aircraft and multiple mission execution capability makes this method even more infeasible. Lacking time, information and resources needed for a full target selection, evaluation/analysis, followed by over-the-target (OTR)[2] calculations along both of the two land frontiers, I will utilize a simplified form of war gaming-derived force-on-force attrition-based method to calculate my assessed IAF's force structure needs for 2032. To avoid OTR calculation complexities and keeping in mind multirole capabilities of aircraft planned for IAF service in the future, I will utilize an air-to-air scenario for my calculations on the assumption that in an era of transparency of the battlespace,[3] all aerial missions[4] will be challenged by opposing air power and, hence, air-to-air engagement disparity can be leveraged to advantage.

It is quite true that the most difficult place to destroy a fighter is in aerial combat and air power purists will rise to object to this method due to their legacy knowledge over the years. Despite this, I will look at the air-to-air arena due to reasons of reduced complexity and the traditional Indian reluctance to initiate offensive operations ab initio;[5] the latter is very important for seizing air superiority with enemy air power destruction on the ground.[6] I will then compare my results with the publicly available IAF plans for 2032 to come to my recommendations for force structure development.

## Nature of Aerial Engagements

The IAF has trained to very high standards in within visual range (WVR) combat and is arguably second to none in this field, as buttressed by

IAF experience in international exercises[7] with advanced air forces that operate state-of-the-art Western equipment. However, advent of new generation, infra red (IR)-guided all-aspect air-to-air missiles (A4Ms),[8] such as the R-73E, Python-4, Python-5, AIM-9X, ASRAAM[9] and Iris-T, has made the WVR arena exceptionally lethal, wherein likelihood of one of the engaged aircraft being shot down is very high, with possibility of a superior pilot being shot down by even a young pilot if the latter carries a more capable weapon.[10] This harsh fact coupled with the relentless advance of technology has led to IAF progressively moving towards beyond visual range (BVR) aerial combat. In the BVR arena, more control can be exercised on the outcome of an engagement. Starting with exercise Garuda-I in 2003,[11] the IAF has, through exposure to advanced air forces, such as the United States Air Force (USAF), Royal Air Force (RAF) and the French Air Force, and through in-house effort, developed an advanced understanding of BVR aerial combat and fully integrated this into its training since the late twentieth century.[12]

**Attrition in Aerial Warfare**

First, it is important to understand that, more than the total number of aircraft deployed, what matters more in war is the number of sorties[13] that can be flown per unit time period. Total numbers matter but good serviceability state and ability to sustain high sortie generation rates matter more as these enable more to be done with less.[14] Hence, the IAF must prioritize increasing serviceability rates across all service equipments. High attrition rates are not sustainable by any air force.[15] While imposing a very high attrition rate on the enemy is desirable, it may not be feasible given resource constraints. An attrition rate of 4 per cent imposed on the enemy, in my opinion, is adequate for our purposes if our own attrition can be contained to below 1 per cent.

In order to simplify the discussion, I will now consider only air-to-air engagements while assuming a common standard attrition figure of 0.25–0.5 per cent to both sides from their opponent's surface-based weapons (AAA and SAMs).[16] Thus, in this deliberately simplified discussion, only the ability to apply a skewed air-to-air attrition on the enemy would decide the outcome.

The history of aerial warfare brings out the importance of higher numbers of aircraft in a specific engagement for success. Two forces equal in numbers and reasonably close in equipment and skills have tended to have equal losses in combat. On the other hand, whenever

the numbers ratio has become favourable to one side, its losses as well as loss percentages have fallen disproportionately, with the opposite effect on the less numerical party.[17] Thus, technology and skills irrespective, numbers do matter[18] in aerial combat.[19] This remains true even today. The slogan of 'fighting outnumbered and winning' has no place at the operational level of war[20] unless a very large technological asymmetry exists.[21] It should be remembered that in more recent times, while war fighting has essentially remained the same, what has changed is just the way of inflicting the desired damage. Hence, the IAF must train very hard to increase its equipment serviceability rates as well as combat crew proficiency. This could be achieved through intense training and realistic exercises.

## Single-front War Requirements

A single-front war may require to be fought against either Pakistan or China. It would be prudent to prepare to fight the more powerful of the two as this preparation would automatically ensure that the lesser foe can also be dealt with.[22] However, major differences between the two threats force a separate evaluation of each. China wields a more technologically advanced and numerically superior PLAAF, while PAF is a relatively small force well trained to fight against a superior foe.

### Single-front War: Western Front (Pakistan)

The Western air forces, with which PAF has exercised regularly since the 1950s, speak very highly of the professionalism and competence of PAF combat crew. Further, PAF has consistently trained to apply itself innovatively against a numerically superior IAF. Comparing the available open source information on third party, post-exercise assessments on the PAF and its pilots' participation with distinction in Arab–Israel Wars,[23] I conclude that the PAF is about even with IAF on the intangibles of tactical innovation, sortie generation rates and aircrew skill/competence.[24] Thus, I place IAF and PAF combat personnel at par giving a comparative ratio of 1:1. So, in sum, one aircrew–aircraft combination of PAF would be equal to a similar combination of the IAF. In such a situation, the larger and better-equipped force could be expected to prevail. The IAF, in order to deal with the PAF, would require fielding a force roughly similar in numbers to PAF, which, it was estimated in the previous article, to comprise a force with 614[25] fighters in 2032. It could be expected to have eight to 12 AWACS/AEW&C aircraft and six Flight Refuelling

Aircraft (FRA). The currently planned IAF force of 42 (756 aircraft) to 45[26] (810 aircraft)[27] squadrons would prove adequate to dominate PAF. On the western front, given the IAF's practice of generating at least three to five sorties per aircraft per day, the IAF would be able to generate considerably more sorties per unit time than PAF, thus gaining an edge and maintaining it. As most IAF aircraft are planned to be multirole capable, the same aircraft would undertake air-to-ground missions as well; reducing attrition to ground-based air defences through extensive use of stand of weapons. The IAF would have an advantage in this respect over PAF through a superior surface-based anti-aircraft capability derived from its medium-range surface-to-air missiles (MR-SAMs), long-range surface-to-air missiles (LR-SAMs), Spyder, Akash, and other weapons. The PAF is unlikely to be able to match all these weapons. Currently, its most advanced SAM system is planned to be the Anglo-Italian SPADA 2000 and Chinese HQ-9, which are not as advanced as the IAF's under-development MR-SAM and LR-SAM. Even PAF's purchase of Chinese reverse engineered S-300 SAMs would not tilt this balance away from IAF. Thus, in addition to higher attrition suffered in air-to-air engagements through being able to field lesser numbers per engagement, PAF is also likely to suffer higher attrition than IAF to surface-based weapons.

Hence, a 42–45 fighter squadron IAF in 2032 is likely to be more than adequate to deal with the threat from PAF in a single-front situation where the western front alone is considered. Through careful planning, it may be possible to make do with even as few as 35 squadrons (630 fighters)[28] on the western front, thus sparing seven to 10 squadrons for manning other areas, without the final outcome on the western front changing, save for it taking a few days more to achieve a favourable resolution to the fighting in the West.

**Single-front War: The North-East Front (China)**

The most likely area for a possible conflict with People's Republic of China (PRC) is the North-East (NE) in a situation of PRC attempting forcible occupation of Arunachal Pradesh (AP). This situation is also the most challenging given the lack of good Indian infrastructure in the NE. With the focus on the NE as the most likely area of border conflict, Lanzhou Military Region (MR) has not been examined in detail.

China has a vast network of airfields in its MRs. However, the airfields in the Chengdu MR, that faces India across the Himalayas, are concentrated primarily in the Yunan province to the east of India, with

**Table 1** Distances between Chinese Airfields and Indian Areas of Interest in the NE[32]

| *Distances between* | *Lhasa Region Airfields* | *Bangda Airfield (east Tibet)* | *Yuanmou Airfield (taken as representative of Yunan province's many airfields)* |
|---|---|---|---|
| West AP–Tibet border near Bhutan (Tawang area in this) | 170 km | 560 km | 940 km |
| Middle of AP–Tibet border | 230 km | 255 km | 750 km |
| Eastern end of AP–Tibet border | 370 km | 290 km | 485 km |
| Tezpur | 325 km | 584 km | 890 km |
| Chabua | 455 km | 395 km | 781 km |
| Jorhat | 430 km | 501 km | 920 km |
| Gawahati | 355 km | 725 km | 1,009 km |
| Bagdogra | 381 km | 967 km | 1,330 km |
| Kolkata | 730 km | 1,195 km | 1,395 km |
| Kalaikunda (KKD) | 810 km | 1,347 km | 1,556 km |

very few airfields on the Tibetan Plateau.[29] Of the several airfields in Yunan province, Yuanmou airfield is taken as representative due its near-central location in the airfield clusters.[30] Bangda airfield lies towards the eastern edge of the Tibetan Plateau towards Kalaikunda.[31]

The distances given in Table 1 indicate that most potential targets in the Chengdu MR would lie within IAF's radius of action (RoA), while all of the NE would be within the PLAAF's RoA.[33] Both PLAAF and IAF are expected to have adequate FRA in 2032. The RoA of all aircraft is expected to be increased by approximately 60 per cent with in-flight refuelling (IFR). Hence, RoA is not likely to be a limiting factor for IAF and PLAAF to engage all targets in the theatre of operations. Tactical routing, when desired, would also be possible given the two air forces' fighters' RoA.

## IAF versus PLAAF Combat Evaluation

### Combat Crew Capabilities

Assessments of PLAAF capabilities bring out several shortcomings such as the PLAAF's historical focus on air defence to the exclusion of other

missions.[34] In the last few years, this has changed as the newer aircraft inducted have viable air-to-surface capability, including ability to deliver PGMs. The PLAAF training for air-to-surface missions has traditionally been weak, a point highlighted in the most authoritative open source Western works from the RAND Corporation.[35] It must be expected that having learned the lessons of the two Gulf Wars as well as Coalition operations in Kosovo, the PLAAF will work towards remedying training drawbacks. The PLAAF is also believed to suffer from inadequate realistic combat training in air-to-air missions,[36] a weakness difficult to overcome in a short time period, though it is likely that given the traditional determination shown by the Chinese in most endeavours, they will do their utmost to overcome this drawback.[37] The PLAAF has commenced air exercises with PAF.[38] This could lead to PLAAF learning advanced tactics from PAF which has had continuous exposure to Western air forces since the 1950s. Therefore, while most equipment in service with PLAAF and IAF in the period under consideration is likely to be more or less evenly matched, the inclination to rubbish PLAAF combat crew capabilities must be avoided. The PLAAF is expected to train ever more effectively for a multitude of combat roles.

The IAF, in contrast, despite its insular attitude from 1947 till the early twenty-first century, has been able to train its combat crews effectively and of late, has also been able to afford to buy/develop the sophisticated weapon systems needed to be truly effective. The IAF performance in international exercises with modern Western air forces has convincingly and consistently demonstrated that its training standards in both air-to-air as well as air-to-surface missions are second to none and that its combat crew are able to adapt to dynamic air situations and implement innovative and effective combat solutions to bring engagements to a favourable conclusion.[39]

The IAF has been exploiting advanced BVR combat theory and tactics for at least two decades as on date, while the PLAAF, as per open source material, is not known to have fully implemented such tactical applications. In the years ahead, PLAAF is likely to fully integrate BVR training into its tactics. Given the initial lead enjoyed by IAF, it should be able to stay ahead of PLAAF with respect to advanced combat tactics in both BVR and WVR scenarios. In this context, it is assessed that, with respect to PLAAF, IAF is likely to retain an aerial combat efficiency and effectiveness advantage of, at worst, 1.5:1 and, at best, 1.9:1, with a mean figure of 1.7:1 advantage for IAF.[40] The rationale for this advantage is buttressed by

the fact that Chinese media, such as *Global Times*, *Xinhua* and Chinamil.com.cn, prominently display articles on live weapon firing training and bad weather/night missions by PLAAF aircrew as great achievements.[41] Such things are routine in IAF and not mentioned as they are considered par for the course from raw 'flight cadet' stage onwards. Converting these figures to more usable ratios through inverting them 1.7:1 in IAF's favour can be used as 0.588 IAF equals 1.0 PLAAF or 1 PLAAF crew–aircraft combination ≡[42] 0.588 IAF crew–aircraft combination (alternatively, this can be stated as 59 IAF aircraft are able to match 100 PLAAF aircraft, of the same generation).

**Sortie Generation Rates**

The PLAAF has historically been known for poor aircraft utilization rates. These have been reported to be consistently as low as two to three sorties per aircraft per week.[43] In the 1979 Sino-Vietnam War, PLAAF averaged one sortie per aircraft (deployed for the war) every five days![44] The PLAAF is also reported to suffer from poor logistics support for its aircraft and other weapons systems.[45] The bulk of the data supporting such claims dates back to the mid-1990s. Subsequent to that time, PLAAF has inducted more modern equipment. It is assessed that these new inductions and efforts to enhance effectiveness of the PLAAF would lead to better utilization rates. In early January 2013, the Chinese leadership explicitly called on the PLA to prepare to fight and win wars.[46] For PLAAF, in the future period under consideration, a utilization rate of two sorties per fighter aircraft per 24 hour period is likely to be the norm. While equipment can be relatively easily obtained or built, training for higher efficiencies of combat crew is a difficult and time-intensive task which cannot be hurried along. Given the state of PLAAF in the mid-1990s, the improvement assumed for it in 2032 is considered reasonable from the author's own experience in training establishments of various types and theoretical study of human productivity.[47] The PLAAF is expected to have 633 fighter aircraft (including 120 fifth generation, 380 fourth+ generation and 153 fourth generation or earlier) deployed in the Chengdu and Lanzhou MRs in 2032.[48] However, given the peace along its other borders and being the controller of the escalation ladder against Taiwan and its other neighbours, PRC could induct more aircraft from other regions when required. However, Chengdu MR, aligned against India's north-east, is unlikely to be able to sustain more than 1,000 fighters at any given time.[49] Thus, PLAAF could be expected to fly a maximum of 2,000

sorties per day.[50] The PLAAF's force multipliers in view of their greater complexity could be expected to fly a single mission per day, providing cover for their fighters almost round the clock in the battle area.

The IAF, traditionally, has catered for a rate of utilization of three sorties per day for strike aircraft and five sorties per day for air defence aircraft and has regularly trained for achieving these utilization rates during exercises. New aircraft inductions with simpler maintenance schedules[51] should lead to three sorties per aircraft per day being achievable by all IAF fighter–bomber aircraft on a sustained basis.[52]

BVR combat is expected to be IAF's choice in terms of engagements with extensive ground-based and aerostat/AWACS/AEW&C cover available to friendly fighters. For achieving a better than 2:0 exchange ratio over PLAAF, IAF would need to fly more than 2,000, ideally 3,000–4,000, sorties per day. At a rate of three sorties per aircraft per day, IAF could achieve this with 1,000–1,300 fighters in the theatre. The IAF would need, after applying the combat efficiency factor, between 1,000 × 0.588 = 588[53] and 1,300 × 0.588 = 764[54] fighter aircraft in order to be able to achieve the objective of winning against the PLAAF in the NE war. Given the similar technology levels of the two air forces, equipment availability rates are assumed to be the same, say, 80–85 per cent.[55] With IAF's norm of 16 + 2 aircraft per squadron, a total of (588/18) = 32.66 ≡ 33 to (764/18) = 42.4 ≡ 43 fighter squadrons would be required in the NE against PLAAF in order to meet required sortie numbers in the expected conflict with China and win. The IAF, while engaged in conflict with China in the NE, cannot leave the northern borders with China as well as the borders with Pakistan unguarded. Hence, IAF will require deploying adequate force along these two borders to ensure that it is able to deal with any unforeseen military situation there. The currently assessed force levels for India, Pakistan and China are tabulated in Table 2. Minimum precautionary requirements along the Indo-Pakistan border are likely to be 15–20 squadrons of third-generation or fourth+ generation fighters apart from other weapon systems. An additional five fighter squadrons are likely to be required to be deployed along the central sector's northern borders and these squadrons could form part of the NE forces that are being routinely rotated for rest and recuperation, hence not requiring any further force levels to be built up.

While the estimated force levels for 2032 for PAF and PLAAF were covered in the previous article of this project, the assessed IAF 2032 force structure, as is known in open sources, is placed at Appendix 'A'.

**Table 2** Comparison of Currently Known Equipment Plans for 2032

| | *IAF* | *PAF* | *PLAAF* |
|---|---|---|---|
| Fighter | 810, including 154 fifth generation | 614, including 20+ fifth generation | 2,464, including over 300 fifth generation |
| Transport/ Special Mission | 322, including 20 AWACS/AEW&C, 18 FRA, 172+ Remote Piloted Aircraft (RPA) | Adequate, 8–12 AWACS, 4+ FRA, 54+ RPA | 336, including 11+ AWACS, 4+ Recce/ Surv/Elint, 3+ Airborne Command Post (ACP) |
| Helicopter | 522, including 8–10 attack helicopter units | 70+ | 538, including 250+ attack helicopters |

*Source:* Vivek Kapur, 'Challenges for Indian Air Force: 2032', *Journal of Defence Studies*, Vol. 7, No. 1, pp. 79–108.

## Assessed IAF Future Force Structure Required

### Fighters

Totalling up, the IAF would need a total of 33 to 43 (+20) = 53–63 fighter squadrons (1,044–1,224 fighters)[56] of fifth, fourth+ and fourth generation in 2032 in order to be able to win a single-front war with China in the NE, while keeping adequate forces available for dealing with any concurrent threat from Pakistan. The IAF is currently cleared by the Government of India (GoI) to build up to 42–45 squadrons by the end of the Thirteenth Plan period (2027).[57] The IAF expects to be at 45 fighter squadron strength by 2032. An additional two to three squadron worth could be held by units such as Tactics and Air Combat Development Establishment (TACDE), Aircraft Systems Testing Establishment (ASTE) and Air Defence (AD) Flights, giving IAF an actual force of 47–48 squadron worth in 2032. Hence, in order to cover the gap while striving for this planned 45 squadron strength, IAF must initiate the case for further expansion to a force level of up to 58[58] fighter squadrons. This further increase could be done in two ways. The first is through GoI sanction for an increase in strength to 58 squadrons. The second method could be to get sanction to form a reserve force on the same lines as the US Air National Guard. This latter method is likely to prove more economical in manpower and equipment exploitation.

### Aircraft versus Missiles

India's ballistic missiles are operated by the Strategic Forces Command[59] and these missiles, with their relatively low accuracy, cannot replace air

strikes.[60] There is an argument for replacement of fighter aircraft with cruise missiles for attack missions. This could form part of the solution once India's Nirbhay, a long-range cruise missile, is inducted alongside Brahmos. However, cruise missiles have many limitations.[61] Supersonic cruise missiles such as Brahmos suffer from very short ranges.[62] Cruise missiles are less effective against targets with very small vertical dimensions due to their flight profiles. Additionally, a single cruise missile addresses just one target and many may be required to destroy a single target. Aircraft are able to fly multiple missions taking on different targets in each of these. Therefore, a one-to-one exchange of fighters with cruise missiles is unlikely to be feasible. At most, cruise missiles could be deployed to make up for shortage of a few aircraft or to supplement the fighter effort. The currently under-development subsonic long-range cruise missile, Nirbhay, could supplement the relatively shorter-range Brahmos in delivering a long-range precision strike capability. If a ground-based surface-to-surface missile unit of the IAF were to field, say, 60 Nirbhay and 48 Brahmos missiles, it could be considered to be equivalent in combat potential to a single flying squadron with a dedicated air-to-ground strike role. Such units could be used as alternatives to strike squadrons.

**Force Multipliers**

The strength of currently planned High Value Airborne Assets (HVAAs), 20 AWACS and 12 FRA, would be adequate if these inductions proceed as already planned.[63]

**Training**

Combat training requires to be ramped up even more than today to ensure that a combat-efficiency edge is maintained and progressively increased over the PLAAF.

**Infrastructure**

Infrastructure of the IAF in the west is very well developed but the east has been ignored to a large extent. However, with the China threat looming, it is essential that IAF rapidly refurbish its infrastructure in the NE. This would entail upgradation of aircraft operating surfaces and hardening of airfield facilities[64] at existing airfields and development of new airfields to full-fledged IAF operational base level. A good road and railway network also needs to be laid in the area to enable efficient logistics flow. In view of long gestation periods for infrastructure development

projects, it is essential that IAF start on this infrastructure development task immediately.

**IAF Organization**

The IAF is organized into two functional commands—Maintenance Command (MC) and Training Command (TC)—and five operational commands: Western Air Command (WAC); South Western Air Command (SWAC); Central Air Command (CAC); Eastern Air Command (EAC); and Southern Air Command (SAC).[65] The IAF has traditionally treated WAC and SWAC as the two proper operational commands. Given the potent PLAAF threat, EAC and CAC would require to be treated as the prioritized operational commands alongside WAC.[66] The IAF organizational issues will be discussed in-depth in a later article.

**Manning Levels**

The IAF must endeavour to ensure that its combat crew to equipment ratio is raised to at least 2.5:1 in order to enable effective utilization of the available war-fighting potential. This will require an extensive and focused training programme. Support manpower would also require to be adequate in numbers and training. This aspect will be looked at in detail in a later article.

**Transport Aircraft**

The ground infrastructure in terms of roads in the NE has been neglected over the years, but is now reportedly in process of being refurbished.[67] Indian Army would mobilize and move forward to its border posts and locations by road with induction from the rest of the country being by rail or road. The Indian Army is expected to deploy eight mountain divisions[68] on the land borders in the NE.[69] The enemy is expected to interdict at least some of the roads required by our army for resupply of men and material. In a case of land routes of resupply being interdicted, there will be need for aerial resupply of petrol, oil and lubricants (POL), ammunition and other essential stores to such army units. There may also, at times, be need for induction of work reinforcement to some locations as well as inter-area transfer of troops and equipment to meet emergent situations. With eight divisions deployed in the area, it would be prudent for IAF to cater for aerial resupply of at least two divisions engaged in combat. 'Inter-area transport of troops' capability should exist for at least two mountain brigades.

It is understood that all army units would have integral reserve supplies for emergencies. A worst-case situation is considered here of reserve not being available or being already expended. The IAF transport assets cannot be built up in a hurry; hence, it is prudent to have assets in being catering for the worst-case situation. One division has approximately 15,000 troops and includes three to four artillery brigades, each with 18 guns. Assuming that each gun fires 150 rounds per day, the replenishment requirement in terms of ammunition for an artillery brigade would be 18 × 150 × 40 kg = 108,000 kg per day. Thus, for each division, 108 × 3 = 324.0 tons of artillery ammunition requires to be catered for in addition to 15 tons of food at the rate of 1 kg of dry ration per day per man and 15,000 × 5 kg = 75 tons of small arms ammunition of various calibres per day. In addition, POL to the tune of 14 tons would also be needed, giving total airlift requirement of 428 tons per day per division. If IAF caters for two divisions, this amounts to 856 tons per day.

An IL-76 can, in practice, carry 40 tonnes of load; a C-17 can carry 77 tonnes; and a C-130J can carry 20 tonnes. A Mi-17 helicopter can carry 3 tonnes up to an altitude of close to 5–6 km above mean sea level (AMSL); and a CH-47 Chinook can carry 4 tonnes to similar altitudes.[70] Air supply of stores will require a mix of airdropping and air landing due to limited availability of drop zones of required size. Air landing is not likely to be possible by IL-76 aircraft, while C-17, C-130/Medium Transport Aircraft (MTA) may be able to land at some forward airstrips and Mi-17/Chinook helicopters may be able to land at most locations. Of the total load to be delivered to a division, it is assumed that 60 per cent can be airdropped and the remainder needs to be air landed, with 20 per cent of the total air–land load able to be done by C-130 class of aircraft and the last 20 per cent of the total requiring helicopter carriage due to topography. Thus, with this calculation, 0.6 × 856 = 513.6 tonnes would require to be airdropped daily by IL-76 /C-17 aircraft, which would consume 12.86 or 13 IL-76 sorties or 6.67 = 7 C-17 sorties; alternatively, this could be done in 26 C-130/MTA sorties (at the rate of 20 tonnes per sortie).

For transport aircraft, in view of the much greater time needed for loading and offloading, it is assumed that two sorties are possible per day. Thus, the heavy-lift effort requires at least seven serviceable IL-76 or four C-17 aircraft being available for operation in the theatre. Air landing of 171.2 tonnes would require nine C-130 sorties. If the entire airdrop effort is carried out by Il-76/C-17 aircraft—with C-130s not being required to

carry out any airdrops—then nine serviceable C-130s would be required in the theatre."Taking serviceability of 60 per cent for IL-76 and 80 per cent for C-130 and C-17 aircraft, this translates to a requirement of 12 IL-76 aircraft, five C-17 aircraft and 12 C-130 aircraft in theatre, working out to one C-17 squadron and 1.5 squadrons each of C-130 and IL-76 aircraft (at the IAF norm of eight to 10 aircraft per transport squadron), with some spare effort available for emergencies and purely IAF tasks. Airlifting of 171.2 tonnes by Mi-17 would require 57.06 or 58 sorties from 29 serviceable aircraft in theatre, which would require a total of 39 aircraft in theatre at average serviceability rate of 75 per cent. By CH-47 Chinooks, this would require 43 sorties from 22 CH-47 helicopters. At 75 per cent serviceability, this works out to 29 aircraft. This translates to four Mi-17/three Chinook squadrons in the theatre (at the IAF norm of 10 aircraft per helicopter squadron).[71]

The Mi-17/Chinook helicopters could also supplement the available firepower in the area in the armed helicopter role. With Indian Army expanding its aviation corps to include integral intra-theatre heli-lift capability and attack helicopter capability, this rotary wing should be adequate. The IAF's planned two squadrons of AH-64 Apache attack helicopters would be deployed in this area and by 2032, should be expanded to six attack helicopter squadrons in the NE to give each division dedicated helicopter fire support capability. Indian Army's own attack helicopters would cover the shortfall, if any. Eight advanced light helicopter (ALH) squadrons would be required to provide light air communication capability to the divisions deployed in the NE. Remnants of the upgraded Mi-25 attack helicopters would remain on the western front in view of their limited altitude capability, with light combat helicopter (LCH) units deployed in the northern areas.

Other tasks for IL-76 and C-130 class of aircraft would remain, such as air supply of troops in the north Jammu and Kashmir region, including Siachen Glacier, and other operational tasks in WAC, SWAC, CAC, SAC and MC. These tasks could, it is estimated, be met by one squadron each of IL-76, C-17 and C-130/ MTA aircraft, while these commands outside the eastern theatre of operations would require a total of eight Mi-17/ Chinook and 10 ALH helicopter squadrons for IAF roles and missions, including aid to civil authorities. It should be borne in mind that IAF's helicopter force would be supplemented by Indian Army's own expanded aviation assets.

The total number of transport and helicopter squadrons comes to two-

and-a-half squadrons of IL-76 and C-130 aircraft each, two squadrons of C-17 and 12 Mi-17, 11 Chinook and 18 ALH squadrons.

### Structure for a Two-front War

Hence, for fighting a 1.5 or two-front war,[72] the IAF would need total of 33–43 (+20) = 53–63 fighter squadrons of fifth, fourth+ and fourth-generation fighters in 2032. The total number of transport and helicopter squadrons required comes to: two C-17; 2.5 IL-76 and C-130/MTA squadrons; 12 Mi-17; 11 Chinook; 18 ALH Dhruv; and eight attack helicopter squadrons. In addition, the IAF would need 'Enhanced Prithvi'-based anti-ballistic missile (ABM) systems, adequate SAM and AAA assets for defence of its bases and other vital areas (VAs) and vital points (VPs). The IAF, reportedly, already has plans to cover its entire territory with ground-based radar cover and aerostat radars supplemented by AWACS. The AWACS and AEW&C requirements would be 20 aircraft in five squadrons of four aircraft each, as planned already.[73] The IAF would also require reorganization to some extent to incorporate introduction of advanced systems such as ABMs. Progressive induction of unmanned aerial vehicles (UAVs) is expected to continue, keeping in mind that UAVs will supplement and not replace manned aircraft in most tasks until such time as their technology matures adequately for unmanned combat aerial vehicles (UCAVs) to be effective weapon systems. Deployment of two-thirds of this IAF is envisaged to be in EAC and CAC, with the remaining one-third being based in WAC, SWAC and SAC.

### Recommended Overall Force Structure of IAF, 2032

In order to be able to fight a two-front war and win in the NE, while maintaining the status quo in the west, the IAF would require building a force as listed below. This projection also takes into account the IAF's role in carrying out its wartime tasks effectively.

- *Fighters:* 53–63 squadrons of (fifth generation, 4.5 generation, fourth++ generation and fourth+ generation) fighters. The 53 squadron force would be adequate in case the numbers tend to be biased towards fifth-generation fighters; and if the majority (over 50 per cent) of the fighters are 4.5 generation or below, 63 squadrons would be prudent to cater for a two-front war. After

a careful study of the ground targets to be destroyed, IAF could elect to field surface-to-surface cruise missile units in place of a few squadrons. This argument is not being extended in this article as a target study would be required to cull out those predetermined targets that can be destroyed through cruise missile attack. This study requires access to the lists of predetermined targets that are believed to be prepared in peacetime by all military services the world over. These lists are almost certainly classified and hence, cannot be accessed. In addition, towards OOAC may need to be maintained. Induction of long-range cruise missiles could reduce fighter numbers marginally. The final mix of fighters and long-range cruise missiles would require to be worked out by operations staff aware of actual target sets and operational requirements. Without live data, it is assessed, that a force of about 90–100 stealth-modified Nirbhay/other long-range cruise missiles could be counted against one attack/strike squadron.[74]

- *Transport Aircraft:* For the border war and conventional tasks, IAF would require two C-17, 2.5 IL-76 and 3.5 C-130/MTA squadrons. For OOAC tasks, further squadrons would need to be maintained.
- *Force Multipliers:* IAF would require 20 AWACS /AEW&C and 12 FRA aircraft. The OOAC task would require additional AWACS or AEW&C.
- *Helicopters:* IAF would require a total of 12 Mi-17-1V/11 Chinook class and 18 ALH, 10 attack helicopter class of helicopter units for its peace and wartime tasks. This would be supplemented by Indian Army's aviation corps.
- *Weapons:* IAF would rely primarily on PGMs for ground attack due to requirements of combat effectiveness. Costs should be reduced through indigenous design and manufacture of PGMs.
- *Organization:* IAF would require building infrastructure, especially in the NE, on a war footing. Air commands would be reorganized to make EAC and CAC full-fledged operational commands at par with or even ahead of WAC, with SWAC assuming a quasi-feeder command role.

## Recommendations

The examination of the required force structure to effectively meet the external challenges lead to the following recommendations:

- IAF must pursue its re-equipment plan with vigour. The currently planned 45 squadron force should be expanded to 53–63 fighter squadrons. If the numbers of fifth-generation fighters are increased, then 53 squadrons may suffice. However, if 4.5 and fourth+ generation aircraft numbers are enhanced, then a target of 63 squadrons should be aimed for. These figures are quite reasonable considering that as far ago as the mid-1960s, the Tata Committee had recommended a 64 squadron air force for India at a time when the threat was far more benign.[75] Additional forces should be raised for OOAC requirements. Induction of stealthy long-range cruise missiles could help moderate these squadron numbers somewhat.
- Till production can be ramped up, the retirement of older types of aircraft should be delayed in order to maintain numbers. In the worst case, aircraft types already retired could be reinstated to cover shortfalls.
- In the period between this stopgap measure and induction of the definitive aircraft, diplomacy must be used to ensure that no military situation requires utilization of force.
- The transport fleet should be upgraded to include two squadrons of C-17, 2.5 squadrons of IL-76 and 3.5 squadrons of C-130/ MTA.
- IAF's helicopter fleet should comprise 12 Mi-17-1V/11 Chinook, 18 ALH class helicopters squadrons and 10 attack helicopter squadrons, in addition to 12 VIP duty AW101 helicopters in one squadron.
- Air commands be realigned to designate EAC, CAC and WAC as the main operational commands with two-third of IAF assets earmarked for EAC, WAC and CAC; SWAC be an operational command of relatively lesser importance and a 'feeder command' for EAC, CAC and WAC.
- HVAA plans for 20 AWACS/AEW&C and 12 FRA be aggressively pursued. A further six AWACS/ AEW&C be raised and maintained for OOAC tasks.
- Currently known plans for upgradation of the radar and other electronic systems be progressed as planned.
- SAMs be inducted in adequate numbers as per current plans and the indigenous ballistic missile defence (BMD) system be integrated into the IAF's AD system.
- Infrastructure development, especially in the NE, including rail,

road links to airfields as well as development of new military airfields, while enhancing facilities at existing airfields, be taken up on a war footing. Hardening of airfields should be a priority.

- Development of PGMs be prioritized to enable their widespread use in all IAF air-to-ground missions. PGMs would be the most common weapons used by IAF with indigenous design and manufacture to reduce costs.
- Stealthy versions of Nirbhay, Brahmos and Brahmos-II be developed on priority.
- Defence Research and Development Organisation (DRDO) to be tasked to develop versions of Prithvi, Agni and other ballistic missiles with terminal homing capability for higher accuracy.
- Training be prioritized in order to maintain an edge over the potential adversaries.
- A separate OOAC force be especially raised, trained and maintained under a designated joint expeditionary force command apart from the regular air force structure.
- IAF must become a major and active stakeholder in the development of new technology and tactics through increased interaction with institutions of higher learning if required.

## Appendix A: IAF Planned Force for 2032

The known slow progress of Indian R&D as well as procurement programmes has been factored in in the assessments of the IAF's Assessed 2032 ORBAT. The Chinese ability to progress on schedule has been included in the PLAAF Assessed ORBAT 2032 in the first article.

**Table AA1** Expected IAF ORBAT 2032[76]

**Fighter Aircraft**

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 1. | Su-30MKI | 112 | 272 Su-30MKI due by 2016–17;[77] in line to undergo super 30 upgrade.[78] |
| 2. | Super 30 | 160 | Heavy UPG to 4.5 generation.[79] |
| 3. | Mirage-2000H/UPG | 40[80] | Numbers post losses; due for replacement. |
| 4. | MiG-29B/UB UPG | 50 | " |
| 5. | Jaguar | 100 | After upgrades;[81] possibly due for replacement. |

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 6. | Rafale | 126 | Rafale, possibly undergoing first mid-life upgrade. |
| 7. | LCA Tejas Mk-2 | 108 | Definitive variants with GE414+/Kaveri engines. Possibly undergoing mid-life upgrade. Possibly higher numbers may be there. |
| 8. | FGFA[82] | 144[83] | Possibly undergoing mid-life upgrade. |
| 9. | Advanced Medium Combat Aircraft (AMCA)[84] | 10 | Entering service; definitive variant under development. |
| | **Total** | **810**[85] | Including 154 FGFA, 160 4.5 generation, 238 fourth++ generation, 110 fourth+ generation and 267 legacy fighters—810 in 45 squadrons. |

**Transport and Special Mission Aircraft**

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 1. | IL-76MD | 12 | Being retired, 12 left in service of earlier 17. |
| 2. | C-17 | 16 | Heavy lift ruggedized performance. |
| 3. | An-32 | 90 | Medium transport (4–6.7 tonne practical load). Re-engined and upgraded. |
| 4. | C-130J | 12 | Special mission (maximum load 20 tonne). |
| 5. | IL-78 | 6 | FRA. |
| 6. | Airbus FRA | 12 | ” |
| 7. | Phalcon | 5 | AWACS. |
| 8. | Airborne Early Warning & Control (AEW&C) | 15 | Indigenous, on EMB-145 airframe. |
| 9. | Embraer Legacy | 4 | VIP communication. |
| 10. | B-737 | 4 | VIP configuration. |
| 11. | BBJ | 3 | ” |
| 12. | Light Transport Aircraft | 40 | 48+ passengers or 6+ tonne load. HS-748 replacement. |

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 13. | Saras | 25 | 19 passengers or 2.01 tonne load. Replaced the D0-228s. |
| 14. | Rustom-1 | 40 | Tactical recce version, airborne time 11–12 hours. |
| 15. | Rustom-2 or Rustom-C | 80 | Precision-guided munitions (PGM) armed variant. Aloft time 24 hours. |
| 16. | HAROP | 10 squardons | 10–12 per squadron. |
| 17. | Harpy | NK | |
| 18. | Heron-I/II UAV | 45/20 | |
| 19. | Autonomous Unmanned Research Aircraft (AURA) Stealthy UCAV | 20 | Entering service. |
| | **Total** | **525** | Includes 205 RPA, 20 AWACS and 18 FRA. |

**Trainer Aircraft**

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 1. | Hawk | 143 | Initial order and follow-on order for 20 placed in 2010–12. |
| 2. | HJT-36 Sitara | 202 | Intermediate jet trainer (IJT). |
| 3. | Pilatus PC-7 | 75 | Primary trainers. |
| | **Total** | **420** | Procurements should be ongoing as IAF expands. Not possible to predict timing/quantum of orders. |

**Helicopters**

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 1. | Mi-25/35 | 23 | May be retained with upgrades. |
| 2. | Apache Longbow-III | 44 | Follow-on orders likely, assumed to be 22 more. |
| 3. | Light Combat Helicopter (LCH) | 60 | Estimated, no orders yet. |
| 4. | Mi-8 | 64 | ” |
| 5. | Mi-17 | 78 | |

| *Sl. No.* | *Aircraft* | *No.* | *Remarks* |
|---|---|---|---|
| 6. | Mi-17-1V | 74 | ” |
| 7. | Mi-17-5V | 139 | |
| 8. | Mi-26 | 8 | |
| 9. | CH-47 Chinook | 20 | ” |
| 10. | Augusta AW101 VIP version | 12 | VIP communication duties |
| 11. | Chetak | 0 | Replaced by ALH |
| 12. | Cheetah | 0 | ” |
| 13. | ALH Dhruv | 195 | |
| | **Total** | **522** | |

The IAF, as brought out in Table AA1, is expected to field a total of 810 fighter aircraft in 2032. Two to three squadron strength more could be held by specialist testing, training and development units, thus giving an actual strength of about 47–48 squadrons with 846–64 aircraft.

## Notes

1. Aircraft are limited by their fuel availability restrictions in staying over a particular area for long periods of time as compared to surface forces.
2. The OTR calculations lie in the domain of air task planers in Air Command Headquarters (HQs) who need to work out the number of weapons that must fall on the target to achieve its desired degradation. Then, they apply probability factors to determine the number of weapons that must be carried by the number of aircraft to achieve the desired result. This is a very complex, highly technical and time-consuming effort which also requires detailed intelligence inputs. This lies outside the scope of the article.
3. Even today, with Airborne Warning and Control Systems (AWACS), Airborne Early Warning and Control (AEW&C) and Aerostat radars widely available, the aerial battlespace is transparent to large measure. Indications are that this transparency will continue to increase in the period till 2032.
4. Whether airborne for air-to-air or air-to-ground weapon delivery.
5. It has been India's experience and policy to respond to enemy attacks rather than initiate hostilities, as seen in 1947–48, 1962, 1965, 1971 and 1999. This historical behaviour has been cited as proof of India's moral ascendancy and peaceful nature. In other words, India's policy appears to be to react but not to initiate hostilities through taking pre-emptive action.
6. In 1967, the Israeli Air Force destroyed the Egyptian, Syrian and Jordanian

Air Forces, essentially on the ground, in a daring pre-emptive air strike. Since then, such a feat has not been duplicated elsewhere. See 'The Six Day War', available at http://www.historylearningsite.co.uk/six_day_war_1967.htm, accessed 31 December 2012.

7. 'India–France Air Exercises: Garuda-2 News & Pics', 4 July 2005, available at http://www.abovetopsecret.com/forum/thread151541/pg1, accessed 25 December 2012; and Baldauf, Scott, 'Indian Air Force, in War Games, Gives US a Run: Foreign Fighter Jets Performed Well against F-16s in Recent Exercises', 28 November 2005, available at http://www.csmonitor.com/2005/1128/p01s04-wosc.html, accessed 2 January 2013.
8. Earlier, close combat air-to-air missiles were able to lock on to their targets best from the rear quarters, homing on to the hot jet engine exhaust signature. A4Ms are able to lock on to their targets from all aspects, including from the frontal quarters as well through incorporating advanced multi-wavelength, very sensitive IR sensors as well as advances in guidance, fusing and warhead technology.
9. Refers to the cooperative West European effort to develop a modern close combat missile called the Advanced Short Range Air-to-Air Missile (ASRAAM).
10. Technology is today playing an ever-increasing role in the trade between human skills and technological advantage. If, say, a mediocre pilot operates a technologically more advanced weapon system against a better skilled opponent, the degree of technological advantage would play major role in determining the outcome; and if adequate technological asymmetry exists, the inferior pilot could defeat his superior opponent relatively easily (for example, a F-22 'Raptor' flown by a rookie against an ace pilot in an obsolete MiG-19). The reverse is more difficult but could, at times, be achievable (say, a rookie in a MiG-29 or F-16A/B being beaten by a skilled pilot in a MiG-21; or a good pilot in a F-15C beaten by a better pilot in a MiG-21 or MiG-29).
11. 'India–France Air Exercises: Garuda-2 News & Pics', n. 7.
12. The IAF has had BVR-capable aircraft since the mid-1980s and has shown its expertise in BVR combat in many international training exercises. Regarding all BVR-capable aircraft ending up in WVR combat, since the Gulf of Sidra incident (4 January 1989)—wherein a pair of US Navy fighters shot down two Libyan MiG-23 aircraft with WVR weapons (AIM-9 Sidewinder missiles) but at BVRs—through the 1991 and 2003 Gulf Wars, air operations in Kosovo, etc., there as been no case of BVR combat ending up in WVR combat. The premise of BVR ending up in WVR dates back to the Vietnam air war in the mid-1960s till the mid-1970s when missile technology was still rudimentary with the US AIM-7 'Sparrow' in its initial versions being the only BVR in use. Since then, missile technology

and reliability has improved manifold. In fact, most modern WVR missiles, such as the Russian R-73E, Israeli Python-4 and Python-5 and the US AIM-9X Sidewinder, boast BVR-like engagement ranges. The last WVR aerial combats were fought in the 1973 Arab–Israeli War and the Falklands War in 1982. Non-effectiveness of AWACS and AEW&C, if due to terrain, would apply to both sides and hence not change the outcome appreciably. Anyone who has entered WVR combat with two aircraft against say four or five adversaries would appreciate the importance of numbers even in WVR combat with close combat missiles. How many of the enemy can a pair of eyes and one brain keep track of while also flying to the aircraft's limits?

13. In aviation jargon, a sortie is one flight or mission of single aircraft from moving off the ramp, taking off, carrying out its assigned task, returning, landing and returning to the ramp, or designated parking point. The word has been borrowed from its use earlier in armies, especially the cavalry where troops often 'sortied forth to meet the enemy' or in other words, moved out from besieged positions to meet the enemy in combat.
14. An air force that can generate five sorties per aircraft per day can generate more sorties than another air force with higher absolute numbers of aircraft but a lower sortie generation rate of say two or three. Say, air force 'A' has 100 fighters and a sortie generation rate of five per aircraft per day; and air force 'B' has 200 aircraft but a sortie generation rate of two/aircraft/day. 'A' would be able to fly 500 sorties in a day, while 'B' would be able to fly just 400 sorties in the same period giving 'A' an advantage in number of targets that can be addressed, etc. In 1971, PAF flew 2,914 combat sorties, while the IAF flew 7,346 combat sorties. Overall, attrition in this war for IAF was 0.48 per cent and for PAF, it was 1.42 per cent. See Lal, P.C., *My Years with the IAF*, New Delhi: Lancer International, 1986.
15. In World War II, bombers of the US 8th Air Force suffered an attrition rate of close to 12–16 per cent, in October 1943, forcing cessation of daylight bomber missions into Germany. In October 1973, the Israeli Air Force lost 40 fighters in one afternoon (approximately 4 per cent attrition on sorties-flown basis and 10 per cent attrition on total aircraft owned) over the Golan Heights to Syrian forces forcing cessation of all Israeli air operations till a solution could be found. Also, see Warden, *The Air Campaign*, pp. 10–60.
16. Both sides, the IAF and PAF/PLAAF, are likely to make extensive use of advanced electronic countermeasures (ECMs) to degrade the other side's SAMs and hence, the manufacturers'-claimed high single-shot kill probability (SSKP) of SAMs is likely to fall appreciably. Article length limitations do not allow for an elaboration on this point from historical experience. While modern SAMs and AAA are more potent than in 1971, the anti-SAM/AAA tactics and technologies are also more effective. As mentioned earlier, in 1971, overall IAF attrition was 0.48 per cent and of

PAF, it was 1.42 per cent (see Lal, *My Years with the IAF*), so the figures assumed here should be valid in the more modern scenario of 2032.

17. Japan's attack on Midway in World War II, with 108 bombers and fighters opposed by 26 US fighters, led to the latter suffering almost 100 per cent losses. On 11 January 1944, 238 US bombers escorted by 49 fighters met 207 German fighters in combat. In the resulting engagement, 34 US bombers were lost. About a month later, 941 US bombers and 700 fighters met 250 German fighters, resulting in the loss of just 21 bombers. In June 1982, 90 Israeli fighters met 60 Syrian fighters, resulting in nil Israeli losses, whereas 23 Syrian aircraft were destroyed. See Warden, *The Air Campaign*, pp. 59–60.
18. Numbers will matter always as there are limits to how much a fewer number of aircraft and crew combinations can do. That is why the USAF plans to induct several hundreds (1,763 to be exact) of the fifth-generation F-35 Lightning-II fighters, and the F-22 fifth-generation fighter numbers were curtailed at 187 due to issues of cost and not projected need by USAF. The US does not have a high-tech enemy since the demise of the Soviet Union, but still sees the need for large numbers of very advanced fifth-generation fighters. This brings in the fact that in combat, numbers will always matter whether in WVR or in BVR environments. Even in the modern age, efforts will be expended to destroy as much of the enemy's assets as possible on the ground, despite the enemy's efforts to protect these. I have factored in training and tactical skills to leverage these aspects in dealing with an enemy with superior numbers. However, in individual engagements, ability to use a larger number of aircraft will matter. At Red Flag exercises, the lowly and humble Jaguar (an optimized air-to-ground attack aircraft with minimal air-to-air capabilities) has, through utilization in larger numbers in a trail/or train (one behind the other in a long line) formation, shot down the mighty F-15 'Eagle' when the F-15 pilots could not cope with the situation of large numbers of Jaguars and got sandwiched in between the Jaguar formation members. A German fighter pilot, Oswald Boelcke (19 May 1891–28 October 1916), formulated rules for aerial fighting and laid these down as the 'Dicta Boelcke'. These rules emphasized utilization of not individual aircraft but formations (or larger numbers) of aircraft, and the dicta formulated in the early twentieth century remain as true today as they were during World War I; technology, meanwhile, has changed a great deal. Manfred von Richthofen (the Red Baron), Germany's premier fighter ace, was a student of Boelcke.
19. Ibid., pp. 60–65.
20. Ibid., pp. 63.
21. Wishful thinking apart, unfortunately, this does not exist between IAF and PLAAF, or for that matter, between IAF and PAF. The technological

edge is unlikely to change in IAF's favour by 2032 as compared to PLAAF, given the development programmes already underway in the two countries: IAF imports AWACS from Israel, while People's Republic of China (PRC) builds its own AWACS; and IAF buys Rafale, MiG-29K, FGFA, C-17, etc., with grudging transfer of technology by the original equipment manufacturer (OEM), whereas PRC designs and builds its own J-10, J-15, J-16, J-20, J-31 and Y-20. The trend appears to be towards the technology edge shifting more in PLAAF's favour rather than the other way around as per data currently available. Hence, numbers do matter a great deal to IAF.

22. The US prepared to fight the Soviet Union, ensuring that it could thus take on any other nation without additional effort. The PRC currently plans to be able to challenge the US, thus achieving force levels more than adequate to fight any other country.
23. Qazi, Faddy, 'RAF Eurofighter Typhoons Pilots "Beaten" by PAF F-16 Viper Pilots', available at http://www.theregister.co.uk/2011/06/08/eurofighter_beaten_by_f16/, accessed on 25 January 2013. Also, see 'Thread: PAF vs IAF', *Iranian Defence*, 15 May 2012, available at http://www.iraniandefence.com/forums/world-military-forum/1525-paf-vs-iaf.html, accessed on 21 January 2013. PAF participated in 2009 in Air Tactics Leadership Course (ATLC) at Al Dhafra Air Base, United Arab Emirates (UAE), alongside RAF, French Air Force, USAF, Jordanian Air Force and UAE Air Force. Moreover, during Soviet occupation of Afghanistan, in the 1980s, PAF shot down several Afghan/Soviet fighters along the Pakistan–Afghanistan border.
24. It could be quite correctly argued that performance in exercises with peacetime limitations does not translate to actual combat performance. However, in absence of actual wars fought by the concerned nations, there is no other way to judge capabilities except to extrapolate from exercises, while the limitations of these are accepted and understood. Having real live ammunition in the air around one can change things considerably. Constraints of data availability restrict my addressing this point.
25. Including 20 fifth-generation, 534 fourth-generation/fourth-generation+ and 60 third-generation or earlier fighters.
26. Standing Committee on Defence (2011–2012) (Fifteenth Lok Sabha) Ministry Of Defence Demands For Grants (2012-2013) Fifteenth Report Lok Sabha Secretariat New Delhi, pp. 59.
27. At the rate of 18 aircraft per squadron.
28. At the rate of 18 aircraft per squadron.
29. There are four airfields in the vicinity of Lhasa and a few small airfields close to the Line of Actual Control (LAC), just north of the AP border with Tibet.

30. Airfield location coordinates obtained from http://www. scramble.nl and plotting done on Google Earth and distances measured on Google Earth using scale tool, accessed 15 December 2012.
31. Airfield location and plotting on Google Earth and distances measured on Google Earth using scale tool.
32. Ibid.
33. Allen, K.W., Krumel, G. and Pollack, J.D., 'China's Air Force Enters the 21st Century', RAND Corporation Report from Project Air Force, 1995, pp. 111–17; and 'Modern Fighters Combat Radius', available at http://forum.keypublishing.com/archive/index.php?t-99342.html, accessed 2 January 2013.
34. Allen et al., 'China's Air Force Enters the 21st Century', pp. 33–103.
35. Ibid. and Cliff, Roger, Fei, J., Hagen, J., Hague, E., Heginbotham, E., Stillion, J., 'Shaking the Heavens and Splitting the Earth', 2011, available at http://www.rand.org/pubs/monographs/MG915.html, accessed 1 January 2013.
36. Allen et al., 'China's Air Force Enters the 21st Century', n. 33, pp. 120–133.
37. Ibid., pp. 33–109.
38. 'Joint Exercise "Shaheen-1" between Pakistan and Chinese Air Forces Launched, Islamabad', 18 March 2011, available at http://www.paf.gov.pk/18_Air_Exercise.html, accessed 27 December 2012.
39. 'Indo–UK Air Exercise INDRADHANUSH-2007 Draws to a Close at UK', available at http://frontierindia.net/ex-indradhanush-2007-kickstarts#axzz2lpbsg7fN, accessed on 26 January 2013; and David A. Fulghum '3rd Wing Explains "Cope India" Exercise', 10 April 2004, available at http://vayu-sena.tripod.com/exercise-cope-india-article02.html, accessed on 27 January 2013.
40. Author's assessments based upon detailed examination of relevant RAND reports and other open source documents relating to PLAAF and IAF from primarily Western sources.
41. Regular perusal of websites http://www.globaltimes.cn, http://www.chinamil.com.cn, http://www.chinaorg.cn and http://www.xinhuanet.com/english/, accessed daily since January 2007 and last accessed 30 January 2013.
42. Symbol '≡' is used as 'is equivalent to' in this article.
43. Allen et al., 'China's Air Force Enters the 21st Century', n. 33, p. 65.
44. Ibid., pp. 93.
45. Ibid., pp. 55–105.
46. 'China's directive to the People's Liberation Army: Get Ready for War', January

2013, available at http://www.breitbart.com/Big-Peace/2013/01/18/19-Jan-13-World-View-China-s-directive-to-the-People-s-Liberation-Army-Get-Ready-for-War, accessed 24 January 2013.

47. Productivity increases were studied by this author in detail during a Master of Business Administration (MBA) course at Faculty of Management Studies (FMS), University of Delhi.
48. See Table 1.4, 'PLAAF Assessed ORBAT 2032', in Vivek Kapur, 'Challenges for the Indian Air Force: 2032', *Journal of Defence Studies*, Vol. 7, No. 1, pp. 79–108.
49. Assessment based upon analysis of Google Earth images of PLAAF airfields in Chengdu MR. Moreover, China can be expected to fight to win and as per available information on PLAAF doctrine, it would try to impose its will rapidly on the enemy. Chinese white papers on defence bring out the emphasis on gaining 'command' of the air as a first step in local border wars.
50. At the rate of two sorties per aircraft per 24 hours.
51. See Table 1.4, 'PLAAF Assessed ORBAT 2032', in Vivek Kapur, 'Challenges for Indian Air Force: 2032', n. 48.
52. Ibid.
53. After applying the combat efficiency factor discussed earlier.
54. Ibid.
55. Most modern aircraft, since the 1980s, have followed the line replaceable unit (LRU) concept. In this, at the field level, an unserviceability requires ground crew to remove a 'black box', replace it with another, while backloading the unserviceable one for repair and return from the factory. This makes keeping aircraft serviceability high an easier task.
56. Totalling up the requirements marked out above.
57. See 'Indian Air Force', http://www.asianmilitaryreview.com/indian-air-force/, accessed 25 February 2013.
58. Average of 53–63 squadrons.
59. 'Strategic Force Command of India Comes of Age', available at http://www.defenceinfo.com/strategic-force-command-india-comes-age, accessed 13 January 2013.
60. India's Prithvi missiles are claimed to have a circular error probable (CEP) of 25 metres (m), while Agni-5 is claimed to have a sub-200 m CEP. Agni-1, Agni-2 and Agni-3 are claimed to have a CEP of 40 m. These CEPs are impressive and very good for nuclear payloads. However, fighter aircraft train to deliver CEPs consistently of under 10 m for achieving the desired results of air strikes. Hence, India's current ballistic missiles fall well short of being considered possible replacements for fighter aircraft. It is good to remember that a CEP figure means that half of the weapons launched are likely to fall within a circle centred at the target with a radius of that

distance and the rest may fall anywhere outside the CEP circle. Moreover, in aerial attack, an undershoot error is better that an overshoot error due to debris dispersion geometry and target damage probability.

61. Nicholls, David J., 'Cruise Missiles and Modern War Strategic and Technological Implications', May 2000, pp. 21–29, available at http://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCgQFjAA&url=http%3A%2F%2Fwww.dtic.mil%2Fcgi-bin%2FGetTRDoc%3FAD%3DADA425467&ei=qa2VUt7GEoPBrAfwmICwDg&usg=AFQjCNFOPgoneVYUJZPur7UDfcaprLjE4w&bvm=bv.57155469,d.bmk, last accessed on 6 January 2013.
62. Nirbhay cruise missile is expected to have range of 750–1,000 km, while Brahmos range is less than 300 km. See 'India to Test Subsonic Cruise Missile Nirbhay in February', *The Times of India*, 25 January 2013, available at http://m.timesofindia.com/india/India-to-test-subsonic-cruise-missile-Nirbhay-in-February/articleshow/18187656.cms, accessed 28 January 2013.
63. 'DRDO to Develop Indigenous AWACS', available at http://www.defencenow.com/news/1052/drdo-to-develop-indigenous-awacs.html, accessed 31 December 2012; and Pandit, Rajat, 'Europe Pips Russia in Mega Mid-air Refuelling Aircraft Deal', 4 January 2013, available at http://timesofindia.indiatimes.com/india/Europe-pips-Russia-in-mega-mid-air-refueling-aircraft-deal/articleshow/17879413.cms, accessed 4 January 2013.
64. These hardened facilities would include blast pens, Bulk Petroleum Installations (BPIs) and ammunition dumps and crucial communications facilities.
65. Controller General of Defence Accounts, 'IFA (Air Force) Manual', 2008, available at http://cdajabalpur.nic.in/ifa/afmanual/PDF, accessed 1 January 2012.
66. Northern parts of WAC face the western parts of PRC's Chengdu MR and southern parts of Lanzhou MR. The CAC faces central Tibet, while EAC faces Chengdu MR and covers AP also. The SWAC faces just the less dangerous Pakistan threat, while SAC looks after south India and may require to support/supplement Indian Navy's operations in the Indian Ocean.
67. Bhat, Anil, 'BRO's Fast-track Construction in Arunachal Pradesh Bearing Fruit', 16 June 2012, available at http://kanglaonline.com/2012/06/bros-fasttrack-construction-in-arunachal-pradesh-bearing-fruit/, accessed 2 January 2013.
68. Of these, six exist today, and two new mountain divisions are being raised.
69. Shukla, Ajai, 'In a First, Indian Tank Brigades to Defend China Border',

*Business Standard*, 17 September 2012, available at http://www.business-standard.com/india/news/infirst-indian-tank-brigades-to-defend-china-border/486647/, accessed 1 January 2013.

70. 'CH-47 Chinook', available at www.boeing.com/rotorcraft/military/ch47d/docs/CH-47F_overview.pdf+max+load+for+CH-47D&hl=en&gl=in&pid=bl&srcid=ADGEESjO8pBcP-QLg_xD1eV4sPcbnu47BpbyS3qKOSEz8mycJjsykz7qV4rATo_tsPJ-, N_ppROlCR75uzSX7tqOds30gvw6C3xR1IsVRW0l3Iz0PlVfem3Rbx8ff7G9Y_irIzFaZpfGY&sig=AHIEtbTGcQQhSNu1TrR-ePZwYEmX-HYiXQ, accessed 23 January 2013; and discussions with experienced IAF helicopter pilots.
71. Controller General of Defence Accounts, 'IFA (Air Force) Manual', n. 65.
72. 1.5 front and two front: fighting in the NE while holding Pakistan at bay and fighting simultaneously along both the NE and western borders respectively.
73. Raghuvanshi, Vivek, 'India Considers Purchasing More AWACS Aircraft', 19 December 2012, available at http://www.defensenews.com/article/20121219/DEFREG03/312190005/India-Considers-Purchasing-More-AWACS-Aircraft, accessed 30 December 2012.
74. On the premise that one fighter–bomber aircraft is equated to five cruise missiles that feature stealth characteristics through application of low observable technologies.
75. Singh, Jasjit, *Defence from the Skies*, New Delhi: Knowledge World, 2007, pp. 12.
76. This would comprise two waves by all the 500 aircraft. Each wave would be a single mission by each aircraft.
77. Data in the table have been obtained from: *Janes World Air Forces*, No. 34, 2011, pp. 279–86; www.scramble.nl and www.fas.org (accessed 4 December 2012); articles in various aviation journals such as *India Strategic*, *Vayu* and *Aviation Week & Space Technology*; 'Indian Air Force', available at http://anand-indianairforce.blogspot.in/, accessed 22 January 2013; and the news media, with special reference to interviews of senior IAF officers. Data thus assembled were analyzed and educated estimates made to arrive at the final table figures.
78. The super 30 upgrade is a very major upgrade of the Su-30MKI's avionics to include an active electronically scanned array (AESA) radar with low probability of intercept (LPI) capability amongst others improvements. The airframe is to be extensively modified to reduce the radar cross-section (RCS), thus making it stealthier than the Su-30MKI, moving towards fifth-generation RCS figures. Several systems designed for the PAK-FA are to be incorporated in the super 30 bringing it closer to a fifth-generation fighter.
79. Ahmedullah, Mohammed, 'IAF's Sukhoi Jets to be Upgraded to

Fifth Generation Fighters', available at http://rusembassy.in/index.php?option=com_content&view=article&id=3039%3Aiafs-sukhoi-jets-to-be-upgraded-to-fifth-generation-fighters&catid=16%3Apress-on-bilateral-relations&lang=en, accessed 5 December 2012; and 'Super Sukhoi on There Way', available at http://weapons.technology.youngester.com/2011/10/super-sukhoi-on-there-way.html, accessed 5 December 2012.

80. *Janes World Air Forces*, No. 34, 2011, pp. 284–85.
81. Ibid.
82. Fifth Generation Fighter Aircraft (FGFA) is to be developed from the Russian Sukhoi T-50 prototype. The T-50 is likely to lead to Russia's PAK-FA fifth-generation fighter with a variant being developed to meet IAF's specific requirements.
83. Sharma, Rajeev, 'India Cuts Order of FGFA Fighter. F-35 on the Horizon?', 25 October 2012, available at http://thediplomat.com/flashpoints-blog/2012/10/25/india-snubs-russia-on-fifth-generation-fighters/, accessed 2 January 2013.
84. AMCA is DRDO's indigenous fifth-generation fighter aircraft project. This was meant to be a follow-on to the LCA programme and aimed at developing an Indian fifth-generation fighter capitalizing on the learning gained in the LCA programme.
85. A further three squadron worth of aircraft could be held in flying units such as TACDE, ASTE and AD Flights, in addition to two to three aircraft as war wastage reserves (WWR) per squadron. The WWR would usually be kept in storage till required to be activated.