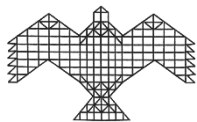


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ASSESSMENT OF AIR POWER IN INDIA AND CHINA

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Executive Summary

The assessment of air power is very significant in the present scenario as India is facing a lot of security threats from China and Pakistan. The role played by the air power in India is evidently seen in the Indo-Pak war of 1947-48 without which India would have lost Srinagar, Poonch and Leh. It is important to understand the vital role of air power in enhancing the security of a state. Analysing the avionics of the fighter aircraft of Indian Air Force (IAF) and People's Liberation Army Air Force (PLAAF) can help in assessing the air power capabilities or more effectively.

Sukhoi Su27, Shenyang J11, Sukhoi Su30 MKK, Shenyang J16, Chengdu J10 are the main multi role fighter aircraft of PLAAF. Sukhoi30, Mirage 2000, MiG 29, Tejas and MMRCRA Rafale are the most important four plus generation aircraft of India. The PLAAF has also indigenised advanced avionics and sensors on the basic russian aircraft. They have also developed the J-20 Fifth generation stealthy fighter aircraft.

In the current era of cyber warfare, the main threat that India can face in the manufacturing of these aircraft are the supply chain risks. India purchase various parts from different countries like Israel, France etc. This also can increase the supply chain threat as a small manipulation in these parts can entirely destroy the aircraft mission. India should have more number of fighter aircraft squadrons to maintain the balance of air power and should have an advanced self-reliant avionics to prevent supply chain risks. Self reliance should be the major driver in acquisition of weapon systems by IAF.

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Key words: Air Power, Force Multipliers, Avionics, AESA radar, Infrared Search and Track, Fifth generation fighter aircraft.

Introduction: Defining Air Power

Winston Churchill defined air power as the most difficult of all forms of military force to measure or even express in precise terms. This statement was made when air power as a military capability was at its infancy. In many aspects Churchill's observation is still valid in the contemporary world. The term air power first appeared in the novel "The War in the Air" by H.G.Wells. From then on many people have defined air power in different ways. The most innovative of currently available definitions that clearly articulate air power's position in the contemporary world defines it as "the ability to project power from the air and space to influence the behaviour of people or the course of events".²

Air power contributes a lot to national security. It is also a dominant factor in projecting a nation's power. So to be secure and powerful, a state should build a strong air power. But this process is not that easy. Increasing cost, complexity of new force multipliers, limited resources have made this task more challenging to many developing countries, especially India. It can be effective when the military power and diplomacy go hand in hand.³ India could seek support from its allies, but should not completely depend on foreign technologies. India should build the capability to develop its own aircraft and technologies, which is not likely possible in the near future but not impossible. It takes decades to acquire aircraft, technologies and to train the crews.⁴ General Hap Arnold said, "Any air force which does not keep its doctrines ahead of its equipment and its vision far into future, can only delude the nation into a false sense of security".⁵ A state should have foreseeable developments and certain technological advances to acquire a strong air power. India has a lot of importance

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² 'Defining Air Power: Part1 evolution of the term', Pathfinder, May 2010.

³ Fali.H.Major,' Indian Air force in the 21st century: challenges and opportunities', IDSA, 2008.

⁴ R.V. Phadke, *Air power and National Security*, New Delhi, Pentagon Press, 2015.

⁵ J.A.Khan, *Air Power and Challenges to IAF*, New Delhi, APH Publishing Corporation, 2004

due to its geopolitical location, size, geo-economic and geo-strategic position in the region. The evident threat to the national security of India is its neighbours- the Islamic Republic of Pakistan and the People's Republic of China. India has a long disputed border with China and Pakistan right from its inception that has threatened the very existence of India as a secular democratic state.⁶ "India and Pakistan are locked not in a geographical dispute but in an ideological war over the present and future of the Indian subcontinent. Pakistan believes in the two-nation theory conceived in the conviction that Hindus and Muslims cannot cooperate as equals"⁷. This twin challenge is the major threat to India's existence. So to deter any attack from its major two neighbours, India should be well advanced in all the fields. India's national security scenario is the long-running dispute it has with the People's Republic of China. A powerful air force is essential to deter any threats from this nation. This research work mainly gives focus on the assessment of the air power in India and China.

Role of air power in national security

National security can be defined as safeguarding of a nation's sovereignty and securing its national interests. In reality, the national security has different components, military forces of a nation along with the air force and naval force is one such component which contributes hugely to its national objectives. The role played by the air power in India is evidently seen in the Indo-Pak war of 1947-48 without which India would have lost Srinagar, Poonch and Leh. Even then India refused to acknowledge the significance of air power in the following years. Therefore, it is important to understand the vital role of air power which includes, to avoid surprise attacks, deterrence through punishment, information dominance, escalation control and quick victory or conflict termination on our terms.⁸

Why the air power is so important in national security is because of its contribution to;

1. Air Superiority
2. Air Defence
3. Long Range Precision Strike (LRPS) for coercion, deterrence and punishment
4. Deep Interdiction
5. Strategic Reconnaissance and Surveillance

⁶A.K.Tiwary,'Birth of the Indian Air force, *Indian defence review*, 2017, <http://www.indiandefencereview.com/news/birth-of-the-indian-air-force-iaf/>

⁷ R. V. Phadke, *Air power and National Security*, New Delhi, Pentagon Press, 2015

⁸ R.V.Phadke, 'Response Options: Future of Indian Air power Vision 2020', Tandfonline, 2008

6. Strategic Lift
7. Operations in conjunction with the land and naval forces
8. Aid to the civil power

There is a need to acquire a strong air power in securing the national interests. But still, there is a gap in the ability of the aircraft to show its full potential. This challenge can be overcome by the use of force multipliers which will enhance the capability of the aircraft to its fullest.

Force multipliers in modern aircraft

Avionics

To develop a strong Air Force India should focus more on its avionics. In simple words it can be explained as “Airborne Electronics” or the electronic equipment in an aircraft. The term Avionics was introduced in USA in the early 1950s. Its role has become more and more important in modern aircraft such that the cost of the avionics system fitted is as much as one-third or more of the total aircraft cost.

The Mission Effectiveness of the weapon platform is improved by enhancing the target sensors (such as Radar, IFF,IRST, Missile warning, etc) for early detection and identification of the adversary aircraft and ground targets, navigation system (INS, GPS, etc) for sensing own aircraft position, velocity and attitude. Active Radar or Passive IRST systems provide essential targeting data to the Mission computer which computes, in real time, weapon trajectories and enables manual /automatic release of the weapons by providing the pilot cues on the Head Up Display and Multi-Function Display. The electronic warfare Systems on board detect enemy radars and missiles through complex monitoring of the electromagnetic spectrum and provide the essential Shield to the aircraft and improve survivability by Counter Measure Systems. This enables the pilot to penetrate easily into the enemy’s territory under all hostile and weather conditions.

Fifth Generation Fighter Aircraft

The 5th generation fighters are designed to integrate advanced technologies into a single platform. This is a unique and revolutionary aircraft with advanced stealth, fighter agility, integrated information and sensor fusion, and a new level of reliability, maintainability and deployability. The Very Low Observable (VLO) stealth technology makes the aircraft less

detectable by the adversary and allows 24/7 operations in all environment. Subsonic, supersonic, high g's, quick acceleration even loaded with air-to-air and air-to-ground weapons make the F-22 and F-35 true fighters. The F-22, with the versatile features of high-altitude super cruise and thrust-vectoring, surpasses any existing or planned fighter.⁹ This generation aircraft has multi-spectral sensors located across all aspects of airframe. It enables the pilot to get a 360 degree view, which enhances the aircraft's ability to make use of its suite of weapons to engage and neutralise an adversary even before they become aware of the threat.¹⁰ These aircraft are networked to allow them to receive, share and store information to enhance the battlespace picture. The 5th generation fighter aircraft helps the pilot to maintain decision superiority over an adversary. This increase the chance of survivability and there by assures battle space dominance.

AWACS¹¹

AWACS are large transport aircraft which are equipped with large radars and hence can detect enemy aircraft at large ranges and hence provide early warning to the flight controllers on ground and also to the fighter aircraft. They are also equipped with Electronic Intelligence (ELINT) and Communication Intelligence (COMMINT) which collect intelligence information about RF emitters inside enemy territory. Together with Net Centric capabilities, AWACS act as eyes of a fighter pilot by providing him with target data in a timely manner leading to the concept of "off board sensing".

Air-to-Air Refuelling

Aerial refuelling is defined as the process of transferring of fuel from an aircraft to another. The aircraft that carries the fuel is known as the tanker and the one that receives the fuel is known as the receiver aircraft.¹² Aerial refuelling effectively enhances the operational range / time of the combat aircraft.

Precision Guided Munitions

PGMs enhance the weapon delivery accuracy, so these are major force multiplier which helps to achieve mission objectives with lesser number of aircraft/sorties. The Laser Guided Bomb

⁹ '5th Generation Fighters', *Lockheed Martin*, https://www.lockheedmartin.com/capabilities/air_power/5th-gen/

¹⁰ 'Five Generation Jet Fighter Aircraft', *Pathfinder*, 2012.

¹¹ AWACS: Airborne Warning and Control System-can provide early warning, depending on its position, detect enemy aircraft on the ground at their bases, or soon after they get airborne.

¹² Menon, 'Understanding Force Multipliers', *SP's aviation*, SP Guide Publications, 2013, [http:// www.sps-aviation.com/story/?id=1307](http://www.sps-aviation.com/story/?id=1307).

(LGB) include a Laser Spot Detector sensor and a guidance kit attached to the free fall bomb and which will provide the actuators on the bomb with guidance signals to home on to the target which is emitting reflected laser energy. Most of the multi-purpose missiles such as the Bunker Buster, Brimstone, Javelin, Hellfire etc. have improved the accuracy and thereby reduced the chances of collateral damage.¹³ Modern PGMs have, in addition to the laser sensor Multi Spectral Sensors to enhance the Kill probability under adverse conditions.

Unmanned Aerial Vehicles

Earlier, reconnaissance in IAF was undertaken by manned aircrafts, but now satellites and UAVs have replaced them. UAVs have already shown their efficiency in the operations carried out against the Taliban and Al Qaeda insurgents in Afghanistan. The armed and surveillance UAVs can be used in weather forecasting, disaster relief, coastal defence etc.¹⁴

Other Aspects

Proper training, leadership, tactics and innovations have also become great force multipliers. Consider the example of Israeli Air Force, an innovation of decreasing turnaround time between sorties increased the efficiency of their air force. Digital avionics which enables continuous fault monitoring and recording enables maintenance personnel to reduce readiness times. Digital Avionics enables training on high-fidelity simulators on ground and saves aircraft flying hours.

Current Status of Air Power

Sukhoi Su27, Shenyang J11, Sukhoi Su30 MKK, Shenyang J16, Chengdu J10, Shenyang J8, Chengdu J7 and Xian H6 are the main multi role fighter aircraft of PLAAF. Sukhoi30, Mirage 2000, MiG 29, Tejas and MMRCA Rafale are the most important four plus generation aircraft of India. The details of multi role combat aircraft of Indian air Force and People's Liberation Army Air Force are shown below:

China's Multi-Role Combat Aircraft

Su-27

The Su-27 is a front-line fighter aircraft which is capable of air superiority missions. Its variants can execute most of the aerial warfare operations. The aircraft has got radar,IRST,

¹³ Harrington, *Jane's defence weekly*, 2010, p.24-31.

¹⁴ R.V. Phadke, *Air power and National Security*, New Delhi, Pentagon Press, 2015.

laser rangefinder and helmet-mounted target designator that provides accurate detection and tracking of enemy aircraft.

Shenyang J11

PLAAF J11¹⁵ is an indigenised multirole fighter using a (Flanker) Su-27 type airframe and advanced Chinese avionics. It has WS-10A engine, weaponry and technologies. It has a reduced RCS, MAWS,IRST composites to lighten the airframe weight by 700 kg. It has an active electronically scanned array(AESA) radar. The J-11B is an unauthorised derivative of the Sukhoi J-11A/Su-27SK, built by Shenyang in China. The aircraft has been the subject of ongoing dispute between Beijing and Moscow which has caused the suspension of production of the second batch on indigenously manufactured legally licensed J-11A/Su-27K. The J-11B is not an exact clone of the Su-27SK. The known differences include:

1. A Chinese IRST set located in the centreline position as with the OLS-27 in early Su-27S.
2. A planar array multimode radar which resembles the Phazotron Zhuk-27 series. It includes an IFF¹⁶ interrogator array.
3. An Onboard Oxygen Generator System (OBOGS). Only the most recent Russian Variants have an OBOGS system.
4. A unique glass cockpit design, with an asymmetric layout quite different from the Su-30MKK/MK2 and Su-27SMK.
5. An optical MAWS system claimed to operate in the UV band.
6. Dielectric panels on the stabilators not seen on any Russian variant

Su-30MKK

The baseline of Su-30MKK has the Su-35/37 vertical tail design, no canards, no TVC capability and Russian avionics. It is a variant of the Phazotron Zhuk planar array radar. The aircraft has an increased maximum takeoff weight against the Su-30/Su-30MKI, requiring structural changes. The Su-30mkk uses the original analogue FCS. It is like the Su-35 a dual

¹⁵ Kopp, 'Shenyang J-11B/BH/BS/BSH FlankerB/C+', *Air power Australia*,2011, <http://www.ausairpower.net/APA-SinoFlanker.html>

¹⁶Identification friend or foe is s system designed for command and control. It enables military and civilian air traffic control interrogation systems to identify aircraft, vehicles or forces as friendly to determine their bearing and range from the interrogator.

role fighter, occupying the same niche as the F-15E but less accurate and less capable in the air-air role as the Su-30MKI.¹⁷

Shenyang J16

The Shenyang J-16 is a multirole fighter aircraft that could perform both 'beyond-visual-range' air to air and precision strike roles. The aircraft has advanced fire-control radar and electronic countermeasures (ECM) suite as force multipliers. J-16 comprise of electro-optic sensor consisting an infrared search and track (IRST) and laser rangefinder, missile approach warning system (MAW) and flare or chaff dispenser. The J-16 have weapon load of 30mm internal cannon with 150 rounds and 12 external stores hardpoints. The J-16 carries air to air mission for short and medium range air-to-air-missiles and for air-to ground mission it carries YJ-83K which is an anti-ship missile, KD-88 air-launched cruise missile, YJ-91 anti-radiation missile, 250kg laser-guided bombs, 500kg stand off sub-munition dispenser 90mm unguided rocket pods etc.¹⁸

Chengdu J10

Chengdu J10 is one of China's multirole fighter aircraft. The latest variant is the J10C which is a single seat fighter and appear similar to the B variant. It is equipped with a active electronically scanned array (AESA) fire-control radar. Its airframe uses increased amount of composite materials to reduce radar cross section profile. J-10 is capable of carrying internally mounted Type23-3 twin barrel 23mm cannon. There are 11 external store stations for the aircraft and these are for carrying weapons. The aircraft can carry PL-8 IR-homing short range air-to-air missiles, PL-12 active radar-homing medium range air to air missile (70-10 km range) and the PL-15 active radar-homing long range air-to-air missile that are beyond 200km. The J-10 carries YJ-83K anti-ship missile, KD-88 air-launched cruise missile, YJ-91 anti-radiation missile, 250kg laser-guided bombs, 250kg low-drag-general-purpose bombs and 90mm unguided rocket pods.¹⁹

¹⁷ Kopp, 'Sukhoi Flankers The Shifting Balance of Regional Air Power', *Air power Australia*, 2012, <http://www.ausairpower.net/APA-Flanker.html>

¹⁸ 'Shenyang J-16', *Sino defence*, 2017, <http://www.sinodefence.com/shenyang-j-16/>

¹⁹ 'Chengdu J-10 B/C', *Sino defence*, 2017, <http://www.sinodefence.com/chengdu-j-10bc/>

J20 Stealth Fighter

It is larger than Sukhoi T-50 and Lockheed Martin F-22 Raptor. The front portion of the prototype looks similar to the F-22 Raptor and the rear section looks like a Sukhoi T-50. Six aircraft are under developmental Flight Trials. The J-20 will give the Chinese air force a long-range, hard-to-detect strike and interdiction fighter that can threaten the air bases, carriers, airborne warning and control systems, and refueling aircraft that the United States and its allies rely on to project air power over the vast distances of the Asia-Pacific. “The forward-mounted canards, poorly shielded engines and underside vertical stabilizers all limit the amount that its radar cross section — which determines how visible the aircraft is to a radar — can be reduced,” Justin Bronk, a research fellow at the Royal United Services Institute in London, has written.²⁰

Multi role Combat Aircraft of PLAAF and IAF

China		India	
Sukhoi Su27	75 ^[1]	Su30 MKI	242 ^[5]
Shenyang J11	205 ^[3]	Mirage 2000	41 ^[6]
Sukhoi Su30 MKK	73 ^[1]	MiG 29	66 ^[7]
Shenyang J16	60+ ^[4]	Tejas	12 ^[8]
Chengdu J10	323 ^[3]	MMRCA Rafale	36 ^[8]

[1] (IISS, The Military Balance, 2014) [2] (World Air Forces, 2015) [3] (IISS, The Military Balance, 2016) [4] (IISS, The Military Balance, 2019) [5] (IISS, The Military Balance, 2019) [6] (Bedi, 2015) [7] (Hoyle, Kwiatkowski, Lewis Rice, & Fafard, 2019) [8] (Press Information Bureau, 2019).

India’s multi role combat aircrafts

Su-30MKI

This aircraft is a multirole combat fighter aircraft. The Su-30MKI is incorporated with thrust vectoring control and canards. It is equipped with aerodynamic airframe made of titanium and high intensity aluminum alloys, providing a leverage in high tensile strength to density

²⁰ ‘China’s Fifth-generation J-20 Fighter Jet has Entered Active Service’, *fighter sweep*, 2017, <https://fightersweep.com/7314/chinas-fifth-generation-j-20-fighter-jet-entered-active-service/>

ration, high corrosion resistance and ability to withstand moderately high temperatures without creeping. The tail beams are joined with twin stabilizers and horizontal tail consoles.

The glass cockpit of the Su-30 MKI accommodates two pilots. The cockpit in the front is assembled with an integrated avionics suite incorporating Elbit Su 967 head up display, primary cockpit and seven active-matrix liquid crystal displays (AMLCD) and primary cockpit instrumentation from Thales. The HAL- built fighter aircraft are assembled with Indigenous Multifunction displays (MFD).

The aircraft integrates a fly by wire (FBW) flight control system. A larger (6*6 inches) colour display installed in the rear cockpit provides for control and guidance of long range air-to-ground missiles. The Su-30MKI is also equipped with a N011M passive electronically scanned array radar, OLS-30 laser-optical locator system and Litening target designation pod to guide air-to-surface missile and laser guided munitions. The N011M will be replaced with AESA (active electronically scanned array) radar. The Su-30MKI is armed with a 30mm Gsh-30-1 cannon. It has 12 hardpoints capable of carrying external stores of up to 8t. The aircraft can carry air-to-surface missiles, including Kh-29L/T/TYe, Kh-31A/P, Kh-59M and Vympel built R-27R, R-73 and R-77 air-to-air missiles. It can also include rocket pods, KAB-500 and KAB-1500 laser-guided bombs. The Su-30MKI aircraft is equipped with a radar warning receiver (RWR) and integrates chaff/flare dispensers and active jammers.

Mirage 2000

It is a multirole combat fighter aircraft. Avionics of Mirage 2000 consists of Thomson-CSF Radar Doppler Multimode (RDM) radar, integrated with electronic counter measures. It is enhanced with fly-by-wire system to replace the manual input and auto-pilot. The navigation complex is assisted with two INS (inertial navigation system). It has laser designation pod with thermal camera. It is modernised with head level display and helmet mounted display. It carries air to air missiles such as MICA, Magic 2, Super 530F, Super 530D Sky Flash and air to ground bombs like BGL 1000, BM 400, BAP 100 and air to ground missiles such as Durandal, Belouga, Armat, Apache, Scalp, AS30L, AM39.

The upgraded Mirage 2000 is being installed with colour multi-function displays under an Indo-French partnership. This is a part of the programme to upgrade India's Mirage 2000H to Mirage 2000-5 MK2 variant with state-of-the-art avionics and latest weapon systems. This is to enhance the operational life of multi-role fighters by around 20 years. The upgrade on Mirage 2000 includes night vision goggle-compatible glass cockpit, advanced Identification

Friend and Foe (IFF) system, advanced multi-mode multi-layered radar and fully integrated electronic warfare suite. It will also have a new firing system for air-to-air MICA missiles.²¹

MIG29

The upgraded MiG-29 has air-to-air refuelling feature that can cover larger distances. It is a multirole aircraft with a combat radius of 1,100 km with additional fuel in the spine. It has the capacity to carry weapons of 4.5 tons. This flight is installed with Zhuk family radar system-Zhuk-M2E. The radar has detection range up to 120km and improved signal and data processing. The aircraft have 6*8 colour MFDs. This flight is found to have some similar features of Mirage 2000 such as-INS, head up display and helmet mount display. The INS is integrated with Global Navigation Satellite System (GNSS). The flight is upgraded with combined interrogator transponder (CIT) and cryptographic national secure mode (NSM). The upgraded MiG-29 can also do air-to-ground and even anti-shipping operations. TheIRST has been upgraded to enhance target detection and identification ranges.

Tejas

Tejas is the smallest combat aircraft developed by Aeronautical Development Agency and Hindustan Aeronautics Limited with a combat radius of approximately 300km. It has 7 weapon stations and can carry 3.5 tons of weapons. Another feature of Tejas is that it has one station for Laser Designation Pod (LDP). Its multi role capability was demonstrated during the Iron Fist by the release of Laser Guided Bombs (LGB), chaff and flare dispensation and R7SE missile within a span of 100 seconds. It includes a EL/M-2032 multimode fire control radar. Tejas is upgraded with open architecture computer (OAC). It amalgamates the functions of earlier mission computer, display processor, video switching unit, mission preparation and retrieval unit. The design is based on open system interfaces standards, which provides interoperability, scalability and portability. OAC drives three multi-function displays, HUD and the helmet-mounted display. Avionics of the Tejas helped to face the challenges of modern warfare.²²

²¹ 'Mirage 2000 fighter aircraft to be upgraded with multi-function displays', *Economic Times*, 14 July 2018, <https://economictimes.indiatimes.com/news/defence/mirage-2000-fighter-aircraft-to-be-upgraded-with-multi-function-displays/articleshow/48732142.cms>

²² 'Tejas', 2015, <http://www.tejas.gov.in>

Tejas Mk1 has an Open Architecture avionics with Glass Cockpit, Quadruple Digital Flight Control System and Extensive use of Carbon Composites in Aircraft Structure. It has eight hard stations to carry sensors, external fuel tanks for extended range and various weapons including BVR missiles and Laser guided bombs.

LCA Air force Mk2 is an improvement over LCA AF Mk1 with higher thrust engine. This aircraft will have improved survivability, maintainability and obsolescence mitigation. Active Electronically Scanned Array (AESA) Radar, Unified Electronic warfare Suite (UEWS) and On-Board Oxygen Generation System (OBOGS) are some of the state of the art technologies planned to be integrated. The cockpit design has been improved with bigger size, smart Multi function Displays (MFD) and smart Head Up Display (HUD).²³

Rafale

Rafale is a multi-role combat aircraft with a combat radius of approximately 1800 km. The avionics of MMRCA Rafale includes RBE2 passive ESA radar which tracks eight targets simultaneously. Real-time generation of three-dimensional maps for terrain following and high resolution ground maps for navigation and targeting. It also has Optronique Secteur Frontal (OSF) IRST which operates both in the visible and infrared wavelengths. The OSF enables the deployment infrared missiles such as the MICA at beyond visual range distances. It is used for detecting and identifying airborne targets as well as those on ground and at sea. The Electronic Warfare suite is SPECTRA from Thales. Spectra incorporate solid state transmitter technology, a DAL laser warning receiver, missile warning, detection system and jammers. The aircraft also contains laser designation pod, sensor fusion, direct voice input and integrated modular avionics. The glass cockpit is Holographic Head Up Display and Head Level Display.

Emerging Threats

The main threat that India faces in the manufacturing of these aircraft are the supply chain risks. There are various ways used by air force to improve performance and reduce costs like global sourcing, lean inventories etc. While these practices are beneficial it can increase the chance of supply chain disruption. For example, having fewer source of supply means a disruption at any one of them is more likely to affect overall performance. Similarly, just-in-time deliveries and lean inventories mean fewer days of operating capacity should a supply

²³ 'The Indian Light Combat Aircraft', *Aeronautical Development Agency Ministry of Defence, Govt. of India*, 2015, <http://www.tejas.gov.in/ADA-Tejas%20Brochure-2015.pdf>

disruption halt deliveries of raw materials or components.²⁴ In the construction of an aircraft India purchase a lot of parts from various countries like Israel, France etc. This also can increase the supply chain threat as a small manipulation in these parts can entirely destroy the aircraft mission. The only solution to this is that either all these should be purchased from a well trusted source or India itself should try to manufacture all these parts by its own.

Consider the example, where United States and Israeli governments used Stuxnet to derail or delay the program to develop nuclear weapons by Iran. Stuxnet is an extremely sophisticated computer worm whose purpose was to cause real- world physical effects. The target of this malware were the centrifuges that were used to produce the enriched uranium that powers the nuclear weapons and reactors²⁵. The Indian Air Force should establish an organisation that is capable of foreseeing the supply chain risks and should come up with policies on how to manage these risks.

Environmental Consideratons

Another major constraint for the air forces is the environmental impact of aviation. Military aircraft would be a major contributor to the environment as it emits heat and other gases into the atmosphere. Studies show that USAF alone uses 2.5 billion gallons of fossil fuel every year. The military aviation should look for other alternative sources and types of fuel. Solar energy and other alternative sources are being considered, but whether it will fulfill the requirements of military aviation is not yet known. Second generation biofuels are more efficient and offer lower carbon dioxide emissions and can be used as a substitute for the traditional jet fuel. Till now it hasn't been in wider use but advocates hope that by the end of next decade a few percentage of world's civil aviation can be supplied by biological sources.²⁶

²⁴ Moore, 'Identifying and managing air force sustainment supply chain risks', *Rand corporation*, 2013

²⁵ Fruhlinger, 'CSO online', 2017, <http://www.csoonline.com>

²⁶ Lewis, 'Military Aviation goes Green', *Aerospace America*, 2009, p.29-36.

Conclusion

The role of military power has increased, as security concerns spread beyond national boundaries. While assessing the airpower in India and China in the current scenario, there is a noticeable imbalance in the squadron strength and in the development of force multipliers such as the avionics. It's high time for India to develop its own AESA radar as China is investing a lot to improve theirIRST and AESA radar system. To achieve advanced capability, India should invest more in R&D, which helps the country to develop weapon systems such as high power lasers and advanced air power warfare system. Also India should acquire the MMRCAs to maintain the air power strength without delaying it further. The Tejas programme should be brought forward by enhancing production rates and enhancements like TEJAS MK II (with enhanced fuel capacity and Canards) should be accelerated. India should emulate and surpass the Chinese in enhancing the capabilities of the Su30MKI aircraft indigenously, as these are the mainstream flagship workhorses. The AMCA programme, (Developing 5th generation fighter aircraft) should be put on the afterburner to enhance the survivability and assure battle space dominance. Self reliance should be the major driver in acquisition of weapon systems by IAF.