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Cover: Dassault Rafale, the IAF's new generation multi role combat aircraft (photo: Dassault)

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Printed at Aegean Offset Printers

Long Term Import

Whatever the play of words that separates the LEMoA (Logistics Exchange Memorandum of Agreement) from the standard Logistics Supply Agreement the United States signs to gain basing and other forms of military logistics support from its foreign allies and partners, there can be no quibble about the fact that India and the US have reached a military agreement with long-term import.

The LEMoA, signed in Washington between Defence Minister Manohar Parrikar and his US counterpart Ashton Carter, began its life in the Indian context in 2002-2003, when the US urged the Atal Behari Vajpayee government to sign it in order to cement ties. While the Vajpayee and Manmohan Singh governments remained chary in view of Indian sensitivities on offering base facilities to foreigners, the Narendra Modi government has pursued the matter in earnest. However, in the recent past, the defence ministry as well as the Air Force and Navy chiefs have expressed their reservations about LEMoA.

India has never before entered into such an agreement with any nation. The Indo-Soviet Treaty of Peace and Friendship only envisaged that the two countries would come to each other's defence if attacked militarily. Given the significance of the deal, the otherwise fairly routine joint statement, signed in New Delhi when US secretary of state John Kerry arrived for the second Indo-US strategic and commercial dialogue pointedly noted that "defence ties form the bedrock of the bilateral strategic partnership". In this context it referred to the status of "major defence partner" conferred on India by the US during Prime Minister Modi's visit to Washington in June, and the LEMoA signed by Mr Parrikar later. Incidentally, the US has conferred the status of "major non-NATO ally" on Pakistan.

The first NDA government of Mr Vajpayee had signed the General Security of Military Information Agreement with the US in 2002. It dodged LEMoA but the second NDA government has gone ahead with it. The two other "foundational" agreements, a requirement of US law, in the defence field remain to be cleared before India-US military cooperation can reach the zenith of its possibilities.

Under LEMoA, neither side is obliged to offer bases. In that sense it is an enabling document — but that makes it more than the thin end of the wedge. As the Indian Army, Navy and Air Force don't roam the world projecting military power while the US does, the one-sided nature of the deal is apparent. However, America won't part with its top-end military hardware, equipped with high-level communications and avionics, unless India signs the "foundational" agreements. In the overall recent context, LEMoA and other "foundational" agreements play into the convergence of Mr Modi's "Act East" policy with President Barack Obama's re-balancing in the Indo-Pacific.

From *The Asian Age*

Chinese Checkers

In a major development, India and the US have sealed the Logistics Exchange Memorandum of Agreement (LEMOA) that will give the militaries of both countries access to each other's facilities for supplies and repairs. LEMOA is one of the four foundational agreements that the US pursues with its defence partners. Seen in the context of the fact that India obtained a 'major defence partner' designation from the US last June, LEMOA represents logical progression in bilateral ties. Accordingly, joint operations between the two militaries will become easier, paving the way for new synergies in the defence sector.

That said, LEMOA doesn't make logistical support automatic or obligatory for either party – requests will be considered on a case-by-case basis. Nor does it allow for US bases to be set up on Indian soil. This is a good thing since New Delhi needs to maintain flexibility in foreign policy. American foreign policy choices can be rash and India would like to maintain its distance from those. However, LEMOA holds significant strategic import against the backdrop of China's growing assertiveness in the South China Sea and backing for anti-India terrorists based in Pakistan. India has legitimate commercial interests in the South China Sea and would be well served in cooperating with the US to keep sea lanes open in the Indo-Pacific area.

Besides, given the way geopolitics is shaping up in Asia, it's natural for New Delhi to seek enhanced defence trade with Washington. India's major defence partner status allows it access to almost 99% of the latest American defence technologies. This needs to be leveraged to incubate a US style military-industrial complex in India that not only creates jobs and furthers self-sufficiency in defence procurement, but also makes India a defence exporter in future. However, this vision can only be actualised through greater Indian private sector participation in the defence sector, which government must facilitate.

From *The Times of India*

Asian Market for Military Aircraft

Since it first rolled out of its Fort Worth factory in the 1970s, the F-16 has been a symbol of US military power. If its manufacturer, Lockheed Martin, manages to win a big overseas contract, though, the F-16 might become the latest US product to get offshored.

Lockheed is vying for a contract to sell fighter jets to India, part of Prime Minister Narendra Modi's $150 billion plan to modernise the country's armed forces. To sweeten the deal, Lockheed is willing to shift F-16 production to the country. Rivals Boeing and Saab have made similar offers to move production to India.

Such proposals show the lengths US military suppliers are willing to go to win customers worldwide. With Pentagon spending hurt by sequestration, the across-the-board budget cuts that took effect in 2013, the biggest US contractors are hunting for new markets. Foreign buyers accounted for 24 per cent of sales for the five biggest US contractors last year, according to Bloomberg Intelligence, up from 16 per cent in 2009. Last year contractors' sales to foreign customers jumped 10 per cent, while US revenue declined 2.4 per cent. Raytheon expects international sales to account for 35 per cent of revenue in 2016, up from 31 per cent last year.

Asia is buying fighter aircraft, as countries such as Japan, the Philippines, and Vietnam respond to moves by China to assert

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territorial claims in the East and South China seas. India, which has its own border disputes with China and Pakistan, is concerned about Chinese attempts to expand Beijing's influence in South Asia. And all countries in the region worry about unpredictable North Korea.

Lockheed has orders to supply Japan with 42 of its F-35 fighters, with most assembly taking place in Nagoya. The $379 billion F-35 programme is the Pentagon's costliest, and Lockheed is depending on Japan, Australia, and other US allies to account for at least 20 per cent of orders.

India is the world's largest arms importer, according to the Stockholm International Peace Research Institute, and depends on imports for 60 per cent of its defence requirements. During the Cold War, India was a reliable customer for Russian-made gear but is now more open to buying from the US Lockheed already builds cabins for the company's S-92 helicopter as well as tail sections for its C-130J transport aircraft in India.

South Korean defence spending last year accounted for 2.6 per cent of gross domestic product-more than Japan or China-and President Park Geun Hye plans on spending even more. South Korea is deploying Lockheed's Terminal High-Altitude Area Defence missiles. Beijing says the system's radar can reach into China and threatens its security.

In May, President Obama announced the US would end its embargo on arms sales to Vietnam. Given the high price tag of much US-made equipment, Vietnam and other Southeast Asian countries "are going to have trouble affording some of these platforms," says Kyle Springer, programme associate at the Perth US Asia Centre at the University of Western Australia. But with US business flat or down, America's defence contractors must go to Asia.

Bloomberg, from *Sunday Business Standard*

The Afghan push

The big news to emerge from Afghan President Ashraf Ghani's visit to New Delhi isn't the $1-billion in aid India will be giving its northern ally, nor the diplomatic agreements it signed with India. Instead, it is this: India's repeated promises over the years that it will back Afghanistan's war against jihadist terror could soon be put to the test.

In a speech at New Delhi, President Ghani described Pakistan as a "revisionist state" trapped in its own fantasies. "Every one of its defeats is celebrated as a victory," he noted, "and every single one of its intelligence failure as confirmation of conspiracy theories." He wryly noted how the Afghan National Army's Helmand Corps commander, on a visit to Quetta, offered to show his counterpart exactly where the Taliban were conducting recruitment.

Early in his tenure, President Ghani irked his public by sending officers to train in Pakistan, and his spies to collaborate with the Inter-Services Intelligence - all in the hope Pakistan would deliver peace. That effort failed spectacularly, undermining his domestic legitimacy. The battered president has turned to India for help.

President Ghani's military wish list from India is, for now, a modest one: More attack helicopters, in addition to those India has already supplied, mobility and engineering equipment, and training. There is a high degree of probability New Delhi will meet these, either directly or by purchasing them from suppliers.

India isn't the only non-Western country pitching in: China and Russia have also made small investments in Afghanistan's army. India's support, though, is critically important, because a long war lies ahead - and the West may well weary.

In recent months, the news out of the country hasn't been good: District after district has fallen to the Taliban, with Afghanistan's 352,000-strong army proving unable to hold ground and stage offensive operations at the same time. The basic balance of force will not change in a hurry. In a country six times as large as Kashmir - and far worse terrain and transport infrastructure - Afghanistan faces a far worse insurgency, but with only as many troops as India deploys.

Given that the West seems unwilling, or unable, to coerce Pakistan into acting against the Taliban, a war of attrition is inevitable. India opens itself up to risks by siding with Afghanistan. However, allowing Afghanistan to be overrun by Islamist warlords would impose terrible costs, too. Either way, India appears to be at the cusp of its most significant overseas engagement since Sri Lanka. Each step forward must be measured.

From *The Indian Express*

Myth and reality

Air Chief Marshal Arup Raha, the head of the Indian Air Force, appears to have gone ballistic, throwing at an aerospace seminar in New Delhi a view that is among the oldest in the RSS armoury of attacks on our first Prime Minister - that what we call Pakistan-occupied Kashmir (PoK) was ours to take militarily if only Jawaharlal Nehru hadn't abruptly ordered a ceasefire. It is true that an untruth repeated a thousand times begins to appear to the gullible as the truth: this is the first principle of successful false propaganda. But more considered opinion with greater regard to historical facts and circumstances don't buttress Air Chief Marshal Raha's line of thinking.

There are many serious reflections on the first Kashmir campaign, one of them by a participant, the late Gen. K.V. Krishna Rao, a former Army Chief and later governor of J&K. Air Chief Marshal Raha could do little better than acquaint himself at least with this soldier's account on the ground realities of the day.

War, it has been quite rightly said, is too serious a matter to be left to generals. And the last thing we need are too many talkative military men. Air power is of course undoubtedly a vital element of warfare. But the Air Chief should also bear in mind that the relentless pounding of North Vietnam by US bombers couldn't prevent America's military humiliation there, and regular American air raids in Afghanistan are yet to settle the matter against the Pakistan-fed Taliban.

From *The Asian Age*

OPINION

Testing the Mettle

Admiral Arun Prakash responds to the views of a critic, who has flayed the upper echelons of India's military as being "visibly dense" and "obviously incompetent". These "uninspiring leaders", according to this critic, rose in Service by managing to "get good ACRs year after year with bland obsequiousness".

One would expect that a civilian would have pretty substantive grounds for such gratuitous and bitter public excoriation of the military. But he makes no dramatic revelations except to cite two old cases of blundering military officers who deserved to be sacked but were probably promoted. "So what?" many would say, "Peter's Principle is well and alive!"

Nevertheless, when an intelligent, tax-paying Indian citizen decides to criticise the military and suggests that *"the military must look within"*; it calls for introspection. However, before commencing the process of soul-searching, three questions come to mind.

Firstly : why does he consider it fair to focus on 'military incompetence' when evidence of, not just incompetence, but inefficiency, bordering on dysfunctionality, stares at him in the face every day – on the part of every single institution in India, including the Parliament, bureaucracy, police, public administration, public works and the criminal-justice system.

And what about the bribery and corruption that accompanies this incompetence, in every facet of public life? For all the flaws that he may perceive in the military, it remains the sole organisation in India that not only functions effectively, but has risen to every occasion, when demanded by national security as well as public good. Apart from assuming 'unlimited liability in defence of the nation's interests', it remains the standard-bearer of ethical conduct – visiting swift and ruthless retribution on the wayward and the corrupt.

Secondly, in a nation, which has, post-independence, gleefully reverted to Mughal norms as far as sycophancy, nepotism, venality and ostentation in public life is concerned, why does he hold the military to higher standards of conduct than the rest of Indian society? And since he does so, why does he not spell out the reasons, bearing in mind that soldiers are not from Mars.

Finally, he is only partially correct when he remarks that, "…we have not had a major war in recent times to test the mettle of our commanders". Surely he is aware that from 27 October 1947, when the 1st Sikhs landed in Srinagar, till today, the Indian military has been engaged in nonstop management of violent conflict, external as well as domestic. Apart from fighting five wars, it has remained occupied with an incessant series of low-intensity conflicts (LIC), involving militancy, extremism, secessionism and cross-border terrorism as well as skirmishes and face-offs along our western and northern borders.

It must be acknowledged that for such a state of affairs to persist for seven decades, there has to be political and diplomatic 'incompetence' of the highest order, as well as dismal failure on part of the bureaucracy to ensure grass-roots development. While fighting LIC may not demand generalship of Napoleonic caliber, I would maintain that it has certainly tested "the mettle of our commanders" and not found it wanting. Sole credit for ensuring that the Indian republic has remained a cohesive entity, for 69 years, in the face of external interventions as well as domestic centripetal forces should go to our military leadership.

This brings me to the crux of criticism that a "stubborn seniority system, adopted from the bureaucracy" eliminates military officers with talent, personality and intellectual curiosity. While there may be a kernel of truth in his perceptions, critics need to be corrected on facts about the selection/promotion system followed by the military.

The military has not 'adopted' any system from the bureaucracy and has its own, perfectly fair, methodology for selection of officers for promotion from the rank of Colonel to General (and equivalents in other Services). The very fact that between 60%-70% officers fall by the wayside, at each stage of promotion, speaks of the fierce competition and stringent selection criteria. Such is the attrition that of a, theoretical, batch of 100, only 6-7 will make it to Maj Gen, 2-3 to Lt Gen and perhaps one to C-in-C rank. By way of contrast, 80%-90% of officers in the Central Services, routinely, make it to the highest pay-grade if not rank, regardless of merit or performance. However, since the military's evaluation system has been termed "opaque", I need to elaborate a little.

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BOEING

Separate Promotion Boards composed of flag-rank officers, are convened periodically for placing officers on a 'select-list' for promotion to ranks of Colonel and above. The boards examine only the 'dossiers' containing annual confidential reports (ACR) rendered on the candidates. These ACRs, rendered by a chain of 2,3 or 4 reporting officers, contain numerical gradings for a number of attributes, as well as a 'pen picture' of about 200-250 words to substantiate the grading. The numerical gradings are awarded out of a (notional) maximum of 10 points and should correspond to one of five classifications: 'exceptionally outstanding', 'outstanding', 'above average', 'average' and 'below average'.

Going by definition and common-sense, most officers in a unit or formation should be graded 'average', with a few being 'above average' and perhaps one or two 'outstanding'; the 'exceptionally outstanding' grading should be seen only in rare cases. Unfortunately, progressive inflation has taken place in ACR marking, over the years, undermining the credibility of the system. The reasons are two-fold: (a) the apprehension of the reporting officer that should his grading become known to the appraisee he will become a disgruntled and non-functional element in the unit and (b) a parochial spirit which compels reporting officers of a certain arm, regiment or specialisation, to boost the gradings of their ilk so that more of them reach higher ranks.

This problem has become most aggravated in the Service where it is mandatory to show the ACR to the appraisee, and an 'exceptionally outstanding' grade (corresponding to a 9/10 marks) has, unfortunately, become commonplace. The Navy does not show ACRs and is a little better in this regard but it is not unusual to see 15 out of 20 officers on a ship being graded as 'outstanding' (8/10). Promotion Boards, when confronted with masses of officers who have received such unrealistic gradings, seek illumination from the accompanying 'pen-pictures'. Unfortunately, this is a vain endeavour because stilted English prevents reporting officers – even at the senior ranks – from spelling out, clearly and concisely, the logic for the high numerical gradings.

Consequently, the Boards have no choice but to resort to computer generated 'merit lists' based on the ACR numerical gradings of the past 5-6 years, averaged out to the 3rd or 4th decimal point. The top scorers in this 'lottery' of rankings are recommended for promotion, and it should not come as a surprise, if a number of undeserving 'bad eggs' sneak into higher ranks.

As far as "obsequiousness" is concerned and how sycophantic officers sometimes gain undue advantage, is a valid point. But this is, obviously, a cultural trait in our society and we all know that age, rank and financial status demand much more deference in India than anywhere else in the world. Consequently, we do have a shortage of Pattons, Yinglings and Boyds, because, sadly, they often get eliminated at an early stage for their non-conformity or forthright views. There is no doubt that the evil of sycophancy – so prevailant in India's politics and society – will undermine the roots of our military unless the senior leadership curbs it ruthlessly and allows 'nay-sayers' to speak up.

The second area of disgruntlement and controversy in the promotion system arises from the fact that the Service Chiefs are entitled to have the last say as far as ACRs of Maj Gen, Lt Gen and (except in the army) C-in-C rank officers are concerned. This is quite appropriate, and the Chief's numerical grading can over-ride any other assessment in the ACR. However, like other reporting officers, the Chief, too, must provide full justification, via written remarks, for overruling the earlier grading(s). Given the fact that the Chief has the power to change relative ACR rankings at the highest levels, there have been allegations, of late, regarding Chiefs contriving or fixing 'lines of succession.'

This is a serious allegation which one could dismiss as preposterous because a 'succession-plan' would require not just improving the standing of 'favourites', but also down-grading competitors on a large scale. Such a plot would involve the connivance of several senior staff officers, who would have to be severely deficient, in morals, to collude in such a grave misdemeanour. However, the fact that such a contention keeps cropping up should be cause for reflection at the highest levels of the Services and lead to more transparency in policies.

The third issue arises from the frequent suggestion that our adherence to the principle of 'seniority' rather than 'merit' for promotion at the 3 and 4-star level breeds mediocrity and harms the organisation. In theory, all promotions at senior ranks are on the basis of 'merit-cum-seniority'. But since everyone who attains Lt Gen/equivalent rank, is assumed to be at the same professional and intellectual level, promotions, actually, take place by seniority. A major advantage of adherence to this system has been that it has prevented intervention by politicians as well as bureaucrats.

However, in real life, there are often significant differences in calibre as well as capability because the individuals would have travelled different routes to reach this rank. By not using the best talent available, the Services, often, harm themselves and demoralise the rank and file. They must, therefore, devise a methodology whereby merit receives a clear edge over seniority in promotions to C-in-C rank as well as to Chief. This methodology should not only be transparent and recorded in black and white, but must also ensure that scope for politico-bureaucratic interference, in the selection process, is minimised.

The last issue relates to some uncharitable comments by our own veterans, that one reads on the Internet, pertaining to the senior military leadership – past and present. Amongst other criticisms, there have been suggestions that Chiefs and senior officers refrain from taking a stand with the MoD on critical Service-related issues, because of the lure of post-retirement appointments.

While personally, I may not be qualified to comment on this issue, I feel that it is an unfair aspersion unworthy of our comrades-in-arms. To debunk it, I need to go no further than my immediate successor, and to point out that as CNS he took a firm and principled stand on the 6th CPC implementation, and was still sent on an ambassadorial assignment, where he distinguished himself.

Be that as it may, in order to kill this kind of unhealthy speculation, amongst the rank and file, it would be a momentous gesture, if the current Chiefs of Staff Committee were to consider, *suo-moto*, renouncing post-retirement government posts; as far as Service Chiefs are concerned. At the same time, they must also consider recommending to the government that henceforth (a) candidates for gubernatorial and ambassadorial assignments will be nominated by the COSC from amongst retiring Cs-in-C and (b) appointees to the Armed Forces Tribunals will be nominated by the COSC from 3-star candidates, considered suitable.

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Air Marshal Brijesh D Jayal (retd) warns of

The Bofors Syndrome

During the recent hearing of a public interest litigation in the AgustaWestland case in the Supreme Court, the solicitor general said that "none involved will be spared and charge sheets will be filed this year." Another report quoted the government pushing for a final discount in the negotiations for Rafale fighters directly with the French Government. It appears that after the Prime Minister's Office's surprise announcement to purchase these combat aircraft in Paris last year, negotiations with the manufacturers are meandering. To these different facets of defence purchases, the recent ministerial expansion and portfolio reallocation have added yet another dimension.

Reportedly, barely 10 days before the ministerial reshuffle, the outgoing minister of state defence, was involved in a major row during a meeting, presumably of the Defence Acquisition Council, chaired by the *raksha mantri*. The MoS blamed members of the army and the defence acquisition wing for a "unfair selection leading to a single vendor" and battled for inclusion of a second vendor and even suggested a probe by the Central Bureau of Investigation into the matter. Not surprisingly, many in the media have linked this episode to his being eased out of the defence ministry.

The case in question was for carbines for the army, which, in financial terms, would be modest as compared to other high-ticket defence systems. That even this has resulted in a piquant situation at such high decision-making levels in the MoD, points to a much deeper malaise afflicting defence procurements, due to which defence modernisation and indigenisation continue to face an indifferent future.

To those in know of the 'system', it was only a matter of time before the perennial conflict between the executive and the user would burst out into the open. Whilst the traditional tug-of-war in the process of endless file-pushing has normally been between the user service and the civilian bureaucracy, both defence and finance, rarely does this involve the political level. Procedurally, the latter comes in only at the finalisation stage, being the proverbial rubber stamp. Indeed, one grouse that the Services often have is that ministers let the bureaucracy hold complete sway, even as projects linger for years, if not for decades – and operational capabilities wither.

This episode thus raises the interesting question of whether a change is creeping in where a minister chooses to be more than just a paper tiger within the defence procurement system and is willing to apply his independent judgment and authority. More pertinently, is the cosy bureaucratic order being challenged within the South Block?

Whatever direction this incident takes, one thing is certain; the army's wait for their carbine is destined to get longer, no matter what the cost to human life. It must continue to do with 'what they have', the pregnant expression used by the then

army chief during a press conference when the nation was faced with the prospect of wider conflict during the Kargil episode. Clearly, the one disposable commodity in our completely broken down defence procurement and modernisation process is the life of those in uniform, for whom, it seems, there is little parliamentary, ministerial or bureaucratic empathy.

If this sounds harsh, one needs to look back at the Indian Air Force's requirement for an advanced jet trainer, the need for which was first spelt out in 1982 and was then endorsed by two high-level MoD committees in 1985 and 1997 to investigate the causes of a high number of accidents in the IAF. Yet, the first aircraft arrived only in 2007, a quarter of a century later! Not surprisingly, the fourth report of the standing committee on defence (1998-99) of the 12th Lok Sabha on the subject, commented: "The Committee feel [*sic*] that the government had been indulging in this procrastinative technique of committing and recommitting the matter *ad nauseam* to various Technical Committees and other bodies with a view to wash their hands off the matter albeit for frequent temporary durations..." This had happened in spite of the government's admission that the non-availability of an advanced jet trainer continued to take a heavy toll in terms of training-related accidents : 543 IAF aircraft were lost during this 25-year period. Yet no persons or 'systems' were held answerable.

The chequered history of defence procurements actually goes back to 1948 when the 'Jeep scandal' made news. VK Krishna Menon, who later became the defence minister, was India's high commissioner at the time and was embroiled in this controversy. But it was the Bofors scandal of 1987, in which 'kickbacks' were paid for the purchase of howitzers for the army, which caused a major political controversy at home. This, in turn, resulted in a defence procurement ecosystem within South Block where procrastination became the *mantra*. The Services termed this the *Bofors Syndrome*, a mindset where few in the decision-making chain would venture to take decisions for fear of falling prey to the shenanigans of others in the complex chain of decision-making. Sadly, over time, this malaise may even have infected some in uniform.

The unique feature of this syndrome is that it works smoothly where government-to-government procurement contracts are concerned, but goes into deep freeze when faced with an open tender purchase. This would explain how, over the decades since 1987, the armed forces have managed to retain some semblance of preparedness, primarily through government-to-government contracts with the erstwhile Soviet Union and later Russia and, since 2007, with over $10 billion worth of purchases from the United States of America. In sharp contrast, the IAF's requirement for the medium multi-role combat aircraft, the army's decades-old proposal for howitzers and many more proposals through the open tender route continue to drift.

The system suffers from yet another malaise. Massive investments over the decades have been made in defence public sector undertakings and ordnance factories to reach the goal of self-reliance in defence. Yet India retains the dubious distinction of being amongst the largest arms importers internationally. One effort to address this imbalance was the Kelkar Committee recommendation in 1995 to select and co-opt some private enterprises, based on their technological and other industrial strengths and designate them as *Raksha Utpadan Ratnas*. They would then be treated at par with DPSUs and inject private competition into the moribund DPSU system. One suspects that the proposal has remained stillborn precisely because the decision-making ecosystem avoids the prospect of choosing amongst private parties.

As part of the post-Kargil review of higher defence management, changes were also introduced in the defence procurement system, with the DAC being chaired by the *raksha mantri*. But the very purpose and spirit of this change, namely to expedite and streamline the procurement process, appears to be viewed as a threat to the syndrome-afflicted ecosystem and it invented a new tool called the Defence Procurement Procedure, the first of which was released with much fanfare in 2002. Over the years, much anticipation and hype accompany each revision of the DPP that every new release seems to be an end in itself rather than the means to an end !

DPP 2016 was the ninth such version recently launched by the *raksha mantri*. It was the first under the current National Democratic Alliance government, which is committed to the *Make in India* mission. There was hence an air of optimistic anticipation, especially with regard to private sector involvement, more so because the Dhirendra Singh Committee, set up in 2015, had proposed a 'strategic partner' model wherein the government would select Indian private enterprises to exclusively make designated military platforms. Not surprisingly, the proposal is proving to be contentious and has become the subject of study for successive committees. Disappointingly, the crucial chapter on strategic partners was missing from DPP 2016. Clearly, the Bofors Syndrome continues to haunt the system.

Whatever the official claims, to impartial observers the underlying spirit of successive DPPs is no longer "delivering and sustaining effective and affordable war-fighting capabilities to the users within a specified time frame" and laying out very broad principles and guidelines to achieve this. Instead, they are being driven by a procedural, legal and defensive mindset where following the book takes precedence over achieving the ultimate objective. The thicker this book, the more reasons one can find to procrastinate.

Defence acquisition is a complex process involving multiple stakeholders. It involves diverse resources and decision systems and should ideally aim to provide on-performance, on-time and on-cost capabilities to the armed forces. This is a mission for committed professionals and not for administrative generalists or, indeed, for uniformed specialists working on rotating assignments, burdened with other chores and pressures. In the US and elsewhere, defence acquisition is considered a full-time profession where people train, specialise and work full-time. The US even has a Defence Acquisition University committed to creating acquisition professionals.

If the erstwhile MoS speaking out in the DAC and setting a new trend of ministerial involvement results in a grudging acceptance that we need a complete rethink of the way the MoD looks at the challenge of defence procurement and self reliance, he may have provided yeomen service to the armed forces. If, on the other hand, we continue to treat modern defence acquisition as a routine administrative chore delivered in the shadow of the Bofors Syndrome, our forces will continue to face future threats with 'what they have'. But the nation should be prepared to bear the consequences.

Geo Politics

Lt Gen Kamal Davar writes on

Military Diplomacy: Furthering Strategic Interests

Confronted with diverse and formidable external challenges to its security and economic well-being, India appears to have discounted one of the most overarching ingredients, which contributes to promoting and sustaining strategic interests, namely, military diplomacy. Also referred to as defence diplomacy, no nation across the world can achieve its foreign policy goals and security interests in today's highly globalised strategic environment disregarding the effective employment of its military instrument.

Down the ages, militaries have achieved national objectives through the use of force. But military diplomacy is just the opposite. While there is no universally accepted definition of this form of statecraft, however, military or defence diplomacy (the term military and defence are interchangeable as it conveys the same, though with the latter one can include the entire defence including its civilian establishment, its R&D institutions) connotes the peaceful, non-kinetic employment of military capabilities and military resources in the pursuit of national foreign policy objectives. This form of diplomacy encompasses high-level ministerial, commanders, staff meetings and engagements, ship/aircraft goodwill visits, training– both at military institutions and in the field-operational cum logistical exercises, regional defence forums (like Shangri La and Raisina Dialogue), confidence-building measures, humanitarian assistance during natural disasters, establishment of air, sea traffic control and communication facilities, construction of specialised infrastructure like ports, airfields, bridges, exchange of specialist military personnel, participation in each other's military parades, fleet reviews or air shows and the like. The exchange and positioning of military attaches of the three services in each other's diplomatic missions has, been since years, an important ingredient of global military diplomacy. In today's terror afflicted world, the exchange of timely terrorist related intelligence will also fall under the purview of military diplomacy.

Military diplomacy endeavours achieving Conflict Prevention and Conflict Resolution and is starkly different to 'Gun-boat diplomacy' which is employed to intimidate or pressurise an adversary with the threat or use of force. Conversely, Defence Cooperation with friendly foreign nations remains an important instrument to strengthen bilateral relations for mutual benefit. However, does India have a well conceived structured approach to defence diplomacy to further the nation's strategic interests merits in-depth analysis.

Goals of Military Diplomacy

Military or defence diplomacy is undertaken to achieve both overall national security and foreign policy objectives. The renowned London *Economist*, had published in its March 2013 issue the lead story *India As a Great Power* which succinctly observed that the "Indian Armed Forces have grown exponentially since Independence, but no civilian leader has the faintest idea how to use India's growing military clout ! " Dr Marc Faber, the well known author of the best seller, *Gloom, Boom and Doom*, has also pithily opined that "India continues to be ambivalent about power, it has failed to develop a strategic agenda commensurate with its growing economic and military capabilities... throughout history India has failed to master the creation, deployment and uses of its military instruments in support of its national objectives." Military diplomacy in India falls under the same paradigm.

Over the last few decades, the global and regional security related environment has witnessed marked changes in its complexities and nuances. These unprecedented changes calls for goals of military diplomacy to be adequately responsive to national goals.

First and foremost, it must be clearly understood by all stake-holders that Military diplomacy does *not* replace the nation's foreign or security policies but supplements them for greater dividends for the nation. It works towards confidence building and development of closer ties between nations and conflict prevention is one of its primary objectives. Secondly, it aims at substantial accretions in the knowledge and progress of the latest techniques and technologies in weapons, equipment, domain awareness in emerging concepts of warfare. Thirdly, and as an extension of the above mentioned, training both theoretical and in the field with joint exercises is a significant feature of this form of diplomacy. All these goals contribute to a nation establishing and increasing its sphere of influence both bilaterally and even multilaterally. Cooperation in non-traditional security areas like disaster management, anti-piracy threats, meeting pandemic threats or assistance in mass evacuations of own and other people from foreign countries in emergency situations are also part of defence diplomacy. A major spin-off of this form of defence cooperation is that, in emergency situations including while participation in UN or other international constituted operations, participating nations work towards understanding each other's tactics and strategies, equipment, logistics, SOPs and thus attain the important asset of interoperability.

However, it needs no emphasis to state that the success of defence diplomacy in a nation will solely depend on the political, security and strategic dialogues to be in sync and complementing each other. Where major defence agreements or treaties between nations are required or even MOUs for military protocols or major purchases/transfers of military hardware are necessitated, the apex political leadership of the nation has to conceive and pilot these thrusts suitably advised by its armed forces, bureaucracy and its foreign policy mandarins.

Evolution of India's Military Diplomacy

Immediately after independence in 1947, India was confronted with realities of the Cold War and the continuous jostling for global dominance between the two superpowers, being the USA and USSR. But for sound geo-political reasons then, India's first Prime Minister, Jawaharlal Nehru, was a staunch votary of 'non-alignment' and all of India's foreign policies were centered around chartering a path independent and virtually equidistant of the two competing power blocs. Consequently, India's defence cooperation and military diplomacy too remained 'isolationist' in its orientation and military linkages with other nations were frowned upon by India's new rulers. The exception to this rule was however, mercifully, India's willing participation in UN peacekeeping endeavours. In addition, during Nehru's prime-ministership, India chaired the UN Neutral Nations Repatriation Commission in 1953 and sent an army contingent and field ambulance to Korea. In addition, during the '50s, India did engage in military diplomacy with Nepal and Bhutan but any noteworthy military initiatives with other nations, apart from visits of Service Chiefs and attendance at some military institutions, hardly materialised. Former Army Chief, Gen Ved Malik in his seminal book *India's Military Conflicts and Diplomacy* has commented that "India started poorly in making use of military diplomacy as a national security and foreign policy tool." He opines that among the many reasons for this malaise, "the foremost being a steep erosion of every aspect of India's military capabilities; civil-military relations, military capabilities, leadership and morale." Gen Malik further lamented that " Nehruvian India was distrustful of the armed forces and kept them out of the Ministry of Defence and important decision making… South Block ensured that policy making was crafted by bureaucrats and strategy by diplomats. Both lacked military expertise or perspective."

As is well known, Nehru's disdain for the armed forces was craftily manipulated by his bureaucracy and the Indian Armed Forces were kept out of the decision making loop even on matters of national security–an anomaly for which the nation had to pay heavily in later years. However, many years on, after the end of the Cold War, India's Defence diplomacy underwent a major transformation both in its span and scale in keeping with emerging foreign policy challenges.

Prior to fast forwarding to the current years, it will be worthwhile mentioning that meager efforts at fostering military diplomacy have existed since the early '50s. Since 1950, India's prestigious Defence Services Staff College (DSSC), at Wellington (Tamil Nadu), has hosted officer students from the three services of 'friendly' foreign nations. Beginning with officers from UK, USA, Australia, Canada and Burma, officers from Non Aligned and newly independent nations such as Sri Lanka, Malaysia, Nigeria, Kenya, Egypt, Indonesia and Ethiopia, Bhutan, Bangladesh and Ghana, among others, send their student officers for this renowned military course each year. A fair number of these officers who attended the course have reached the top positions in their respective service hierarchies besides some of them from the DSSC and India's National Defence College (NDC) have risen to be heads of state of their nations. If some in India's bureaucracy still wish to underplay the significance of military diplomacy, may the Almighty forgive them! India has also been one of the largest contributors of troops on various UN peace keeping missions around the world and its record in this form of military diplomacy has been second-to-none.

It is also worth mentioning that the Indian Armed Forces also globally enjoy a sterling professional reputation, and India

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has been requested by 'friendly' foreign nations to send military training teams to Nepal, Bhutan, Iraq (where this writer served for 2 years), Botswana, Angola, and Malaysia among other nations.

Current Status: Military Diplomacy

India's Defence diplomacy underwent a gradual, yet qualitative, change with end of the Cold War. Today, 73 nations from across the globe have their military representation with a total of 120 officers from the three services stationed in New Delhi. On the other hand, India has a total of 71 military officers as Defence/military/air/naval attaches posted to 44 nations with an increase in the near future planned as regards their numbers and the nations to be represented in.

With the world's now sole super power, the United States of America, India's diplomatic relations, including in military cooperation have been steadily improving since the last two decades or so. The formulation of the *Kickleighter proposals* in 1991-92 gave a fillip to expanded cooperation among the armed forces of the two democracies. This protocol enabled the first ever military to military India and US paratroopers exercise in February 1992. This was followed by exercises by the navies of the two nations dubbed *Malabar I, II* and *III* which have now become a regular annual feature. The last 10 years, in particular, have seen an unprecedented strengthening of the US-India Defence relationship.

In June 2005, India and the US-signed a new framework for expanding their defence relationship over the next 10 years, which agreement was further extended for another 10 years in 2015. India is today the US military's biggest training partner with the US conducting the more military exercises with India than any other nation. In addition, the US has now become the third largest supplier of arms and equipment to India. Gradually, irksome differences between the two nations like transfer of technology, export to India of dual use technology and India signing some strict protocols regarding employment of weapons provided by the US or inspections etc, are slowly being smoothened out.

In the last few years, India has acquired a number of systems including the LPD ship *Trenton*, modern transport aircraft like the C-130J Hercules and C-17 Globemaster III, P-8I maritime patrol aircraft while negotiations for a variety of state-of-the-art systems for the three services are at an advanced stage. The signing of the India US Nuclear Accord between President George Bush and then Indian PM, Dr Manmohan Singh in 2009 took India-US ties to a new level. In the last year (2015-16) the US Defence Secretary has visited New Delhi twice and India–US defence ties are on the upswing. Both the Indian Navy and the Indian Air Force are now regularly participating in US conducted exercises like the *Rim of the Pacific* multilateral and *Red Flag* exercises respectively. The much heralded US-India Defence Technology and Partnership Agreement, under consideration of the US Congress will take defence ties between the two nations to a another level of defence engagement. The signing of the Logistics Agreement between the two nations, will enable both the nations to utilise each other's bases and logistics–indeed a radical departure from the past relationship!

The US is also trying to push India to assume a much larger role in the Indian Ocean in collaboration with Japan and Australia, with an eye on Chinese expansionist inclinations in the South China and the East China Seas. However, this is an area where Indian diplomacy will have to factor in keeping sensitive India-China ties in mind, its border dispute with China and India also ensuring this traditional 'strategic autonomy' not being compromised.

With Russia, defence relations have been an important pillar of our long standing strategic partnership. The Indian MOD opines that "the two countries have a robust, multi-tiered institutionalised mechanism for regular interactions for deepening long standing defence cooperation." India's Defence Minister Manohar Parrikar had visited Russia in April 2015, again in Oct-Nov 2015 to co-chair the 15th meeting of the India Russia Governmental Commission on Technical Cooperation. Last year, an Indian military contingent took part in the parade to commemorate the 70th anniversary of 'Victory Day' which was also witnessed by the President of India. High level visits to discuss various issues among the two nations especially regards weapons, equipment, ammunition and efforts to manufacture Russian equipment in India, like the Kamov Ka-226T helicopter, have been going on intensively. It is important to mention here that with deepening defence relationships of India with Israel and the US, defence cooperation with Russia may take a hit in the years ahead as India diversifies its sources of importing of equipment including for its 'Make in India' programmes. We will have to diplomatically ensure that Russia maintains its historical fraternal ties with India – not an easy call, by any standards, with cash strapped Russia!

Defence Cooperation with China is guided by the *Annual Defence and Security Dialogue* which last held its 7th Meeting in Beijing in April 2015. There have been a large number of visits by high level military delegations to each other's nations during the past few months. Defence Minister Parrikar has again been to China, followed by the visit of Indian National Security Adviser Ajit Doval to Beijing to discuss resolving of India's long outstanding border dispute with China. Indian military diplomacy with the Chinese faces many challenges owing to China's assertiveness both along its land borders with India, its continuing military support to Pakistan, its announcement of the grandiose China Pakistan Economic Corridor which runs through the disputed Gilgit-Baltistan and POK regions which India claims as part of the erstwhile undivided princely state of J&K at the time of partition. China's unabashed assertiveness in the Indian Ocean would propel India to take suitable counter measures with other nations of East Asia. China accords tremendous significance to the role of military diplomacy to further national goals with nobody less than its President Xi Jing himself vouching for the importance of military diplomacy. By all accounts, there exists total synergy between the PLA and the Chinese political authority with three Generals being part of the all-powerful Politburo. The Chinese Navy, especially, is hyper active with numerous goodwill visits to countries across the oceans. China has its military attaches in 109 countries and has strategic and military partnerships with nations like North Korea, Pakistan, Myanmar, Bangladesh, Sri Lanka, Tanzania, Seychelles and Maldives among others. China, recently shed its so-called great power responsibility by vetoing a UN resolution declaring Pak terror chieftain, Jaish-e-Mohd supremo Masood Azhar, a terrorist.

It merits mention here that the Indian Navy has been at "the forefront of lending a military dimension to India's 'Look East' policy unveiled in the 1990s". The policy has now been renamed as 'Act East' by the present NDA dispensation and the Indian Navy has been vigorously reaching out to all the Indian Ocean littoral nations. From 1995 onwards, our Navy has been conducting multi-national cooperation exercises code-named *Milan* in it its out-reach amongst nations in the Bay of Bengal. The International Fleet Review conducted in February 2016 by the Indian Navy at Vishakhapatnam attended by 99 warships from 50 nations, was a spectacular display of India's military diplomacy at work.

As regards its neighbours India has cordial military relations with all except, Pakistan with whom not much should be expected in the foreseeable future. Despite countless efforts by India to normalise relations with Pakistan, the latter continues to follow a highly violent, anti-India agenda in all its strategic and security formulations, particularly in J&K. However, India's Pakistan policies and the latter's terror exports to India, is another subject to be dealt with separately and is not being deliberated upon in this article. Suffice here to mention that India must further step up its military diplomacy with its other neighbours far more vigorously than hithertofore. China, as part of its grand design, in collusion with its protégé, Pakistan, will do whatever it can, to vitiate India's efforts at establishing healthy relations with its neighbours. This is a constant that India's security establishment will have to factor in its formulations.

A Defining Moment

Unmistakably, India today stands, at a defining moment in its evolution as a reckonable global player. The world is, perhaps, more confident of India's eventual rise in the comity of nations than some Indians themselves! Nevertheless, India's rise is concomitant on the wellconceived and determined steps the national government takes to attain that goal. The nation thus will have to energise all the constituents which contribute to the enhancement of India's Comprehensive National Power. Military strength and military diplomacy are but one such vital and irreplaceable component which will go to enhance the nation's ascent in the global community. But for that the nation will have to take some unfaltering steps discarding all the ills which have bedeviled India's governance in the past.

Foremost, the government must give adequate participation in national strategy and national security issues to the Defence Services. It will be in the larger interests of the nation if in the formulation of national strategy, the requisite synergy between the MEA, MOD and the armed forces is achieved. The energetic pursuit of military diplomacy and defence cooperation with nations of interest to India will thence be a natural corollary. Secondly, India must step up its military diplomacy and defence cooperation in a substantial manner with its neighbours like Bangladesh, Afghanistan, Sri Lanka, Nepal, Iran, Bhutan and importantly Nepal with whom our relations do fluctuate from time to time. As Maritime Asia assumes increasingly larger strategic significance in the years ahead, Indian military diplomacy will have to touch the shores of East Asia and better naval cooperation achieved with nations like Japan, South Korea, Philippines and importantly Viet Nam. Our military representation, currently restricted to just 44 nations, must be substantially increased and also span continents like S America besides the nations along the Indian Ocean and Africa.

In addition, our structures and the governmental/services HQ set-ups to conduct military diplomacy are not at all geared for its pursuit. With establishment of the Integrated Defence Staff, after the Kargil War, it will be appropriate to accord to the Defence Intelligence Agency (DIA) the responsibility of conducting defence diplomacy in all its manifestations. On behalf of the MOD and the three services, the DIA can well foster military diplomacy in concert with the MEA and any other ministries involved. The Government of India may wish to note that in today's world, there exist a large number of nations being ruled by military/quasi military governments and a large number of heads of state have a military background. It will be in the nation's interests to send some suitable retired senior officers from the three services as High Commissioners/Ambassadors to such countries, as an example, sending a retired senior officer from an Indian Gurkha regiment to Nepal as our High Commissioner will pay handsome dividends!

As India works for its rightful seat on the 'global high table', South Block has to undergo a radical mind change and integrate military diplomacy as an inescapable constituent of its global diplomacy. As most nations look up to India for increasing security assistance to it, India will have to speedily establish integrated institutions and expertise within to comprehensively reach out to the growing demands and aspirations of friendly foreign nations from India. By synergetic endeavour of all the organs of the state, India can surge ahead and be deservingly counted.

36 Rafales contracted for the IAF

A French Air Force Rafale B performing at Aero India 2015 (photo: Angad Singh)

Defence Minister Manohar Parrikar with his French counterpart Jean-Yves Le Drian, after signing the Agreement (photo: French Embassy in New Delhi)

Cover Story

It has been fifteen years since the Medium Multi-Role Combat Aircraft (MMRCA) competition for 126 new fighters for the IAF was conceived, a decade since Dassault's Rafale multirole fighter was put forward to meet that requirement, four years and eight months since the Rafale emerged as 'winner' of the MMRCA contest, and 18 months since Prime Minister Narendra Modi committed to a drastically reduced purchase of just 36 'flyaway' Rafales directly from France.

On 23 September 2016, Indian Defence Minister Manohar Parrikar and his French counterpart Jean-Yves Le Drian signed a formal agreement for purchase of the 36 fighters. Dassault Chairman and CEO Eric Trappier, who was also present, stated, "I am certain that the Rafale and its performance will hold high the colours of the Indian Air Force. It will demonstrate unstinting efficiency in protecting the people of India and the sovereignty of the world's largest democracy."

French Air Force Rafale fighters in Jodhpur during the Indo-French Garuda-V air force exercise in 2014 (photo: French Embassy in New Delhi)

As Patrice Caine, Chairman and CEO, Thales group stated, "All Thales teams would like to thank the Indian authorities for the trust they have placed in us. Rafale's new export success demonstrates our ability, alongside Dassault Aviation and its partners, to constantly meet the customer's highest expectations through innovation, the mastery of advanced technology and industrial excellence." Thales is responsible for the fighter's RBE2 AESA radar, the Spectra electronic warfare system, various optronics, communication, navigation and identification systems, the majority of cockpit display systems, and power generation systems.

The agreement, valued at approximately €7.8 billion (Rs 60,000 crore) includes 36 aircraft (28 single-seat and 8 twin-seat), weapons, spares, maintenance and support, as well as a number of IAF-specific customisations, such as a helmet sight. The bulk of the weapons package will be supplied by European missile manufacturer MBDA, and includes the Meteor BVRAAM and a range of precision guided munitions. Deliveries will commence 36 months after the contract comes into force, with all 36 aircraft to be delivered within a period of another 36 months.

MoD's Long-Term Integrated Perspective Plan (LTIPP)

The Ministry of Defence has prepared an ambitious plan to spend $233 billion (Rs 1,500,000 crore) over the next 11 years for procurement or production of new equipment, including warships, fighters, submarines, aircraft carriers and helicopters. The funding is projected as part of the financial requirements for the Long-Term Integrated Perspective Plan (LTIPP) for 2012-2027. The MoD is pursuing an 8 per annual cent hike in existing capital spending that is allocated in each year's budget for new military equipment meant for the Army, Navy and the Indian Air Force. According to the plan, the MoD has set a target, including induction of an additional 170 fighters for the IAF, 12 additional submarines, 500 helicopters of various types, additional artillery guns and tanks for the Army and another indigenous aircraft carrier.

Although the outlay appears "immense", the MoD is planning a gradual hike. Capital spending for the fiscal year ending March 2017 is Rs 86,340 crore ($12.69 billion), and the entire planned increase over the next 11 years will average out to an annual spend of $20.27 billion.

India building military capability to counter China

Along with (re-)activation of the Pasighat ALG, India is gradually building up a conventional military capability across all three services that is aimed directly at countering China's perceived military threats. Apart from the XVII Mountain Strike Corps which in the process of raising, the Army is increasing the strength of MBTs deployed near the LAC in Ladakh, with a third regiment of T-72s being sent to the high altitude area, making it a full armoured brigade in this sensitive region. In the east, the MoD has cleared a 2,000km highway in Arunachal Pradesh, connecting Tawang to Vijaynagar, a move that will go some way in reducing China's crucial infrastructure advantage along the border.

In early August, reports emerged that the Cabinet Committee on Security (CCS) had cleared a fourth BrahMos land-attack cruise missile regiment to be raised in the east, with 'steep dive' capabilities particularly suited to mountain warfare.

Air activity in the Andaman and Nicobar Command, crucial for monitoring the IOR and the all-important Malacca Straits, has also increased manifold, with deployment of assets such as IAF C-130Js and Su-30MKIs, and Indian Navy P-8I MR/ASW aircraft.

Renewed offers on US-origin fighters for IAF

The US Government is in "full support" of marketing efforts by Lockheed Martin and Boeing to respectively, sell their F-16 Block 70 and F/A-18 Super Hornets to the Indian Air Force. Following the visit to India in July of Marillyn A Hewson, President Lockheed Martin was the Secretary of US Air Force, Deborah Lee James, while presentations and proposals have been made by senior executives from Lockheed Martin including Randall L Howard, head of F-16 Business Development. Howard stated that "the offer we have given to the Indian Government is unmatched and from our side, unprecedented."

While Lockheed Martin has offered to shift its entire F-16 fighter production line from Fort Worth in Texas to India," to meet both Indian and global requirements", Boeing has similarly proposed that its F/A-18 Super Hornet could be manufactured in India and meet requirements for "futuristic combat aircraft".

Adding to these continuous moves was the "significant support" by US Defence Secretary Ashton Carter who met Indian Defence Minister Manohar Parrikar in late August, visiting the United States. According to reliable reports, General Electric has reiterated its offer to co-develop high thrust jet engine for India's future fighter programmes but the US has linked this with the proposal to manufacture US-origin fighters under the 'Made-in-India' initiative, with the Pentagon "formally putting all options on the table, including transfer of technology related to advanced weapons, radar and powerplant".

It is learnt but the Indian Government is "pleased" with these moves but the US Departments of State and Commerce would have to factored in as clearances on licences and transfer of technology are their responsibilities. A significant reference was made to the Saab Gripen fighter where powerplant in of US-origin : "Since a major component of the Gripen NG, including its engine and radar are US ... there would be no obstacles from Washington on even transfer of technology for (the) Swedish fighter". However, "the Pentagon understands that all these proposals will have to go through the competitive route".

"Gripen for India"

During the India-Sweden Defence & Aerospace Industry Seminar and B2B Interactions in New Delhi on 31 August 2016, Mats Palmberg, Vice President, Industrial Partnership, Saab Aeronautics made the first public revelation of his Company's 'Make in India' approach. Referring to Saab's Brazilian programme, Saab's "key principles are to transfer technology in a much broader and deeper manner, share knowledge and experiences that constitute the actual core of aeronautical capability", the aim being to get an indigenous 'system of systems' integration capability.

Establishing such an aircraft company in India for the Gripen E would lead to joint development of future fighters, it being understood that Saab have also suggested partnership in design and development of India's next gen AMCA.

India and USA sign LEMOA

During his three-day visit to the USA beginning on 29 August, Defence Minister Manohar Parrikar signed the seminal Logistics Exchange Memorandum of Agreement (LEMOA) with the United States, "allowing the militaries of the two countries to use each other's bases for repair and replenishment of supplies". The logistic support covered under the agreement includes supplies and services of food, water, billeting, transportation, petroleum, oils, lubricants, clothing, communication services, medical services, storage services, training, spare parts and components, repair and maintenance services, calibration services and port services. These would be provided either for direct cash payment or for reciprocal provision of logistic support, supplies, and services.

Speaking in Washington DC, Defence Minister Parrikar stated that LEMOA "does not have anything to do with the setting up of a base. It is basically logistics support to each other's fleets, like supply of fuel, supply of many other things, which are required for joint operations, humanitarian assistance and relief operations." US Secretary of Defence Ashton Carter added that the agreement would make joint operations between the two militaries easier and more efficient. "What it does is make possible and make easier operating together when we choose to," he stated.

Parrikar visits Boeing CH-47 production facility

At conclusion of his three-day visit to the USA in August, Defence Minister Manohar Parrikar flew to Philadelphia to visit Boeing's CH-47 Chinook rotorcraft facility, where the IAF's future heavy-lift helicopters are being built. India's contract for 15

CH-47F helicopters, signed in September 2015 and worth around $1 billion, will have Boeing deliver the first Chinook in 2018 and the last by 2019.

The Chinooks will supplement and eventually replace the IAF's remaining Mi-26 heavy lift helicopters. The Indian MoD also ordered 22 AH-64E Apache Guardian attack helicopters from Boeing in 2015, which are being built at the Company's Mesa (Arizona) rotorcraft plant.

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Predators for India

According to sources in Washington DC, "the US Government is likely to respond positively" to India's request for 22 General Atomics Predator Guardian UAVs "which would act as a force multiplier for Indian maritime surveillance requirements. The US Government has not conveyed a formal decision yet but is believed to have begun an inter-agency process on the official Indian request.

The process reportedly began after India was designated a "major defence partner" of the US, following Prime Minister Modi's meeting with President Barack Obama in June. The Indian Navy had earlier sent an official letter of request (LoR) to the US Department of Defence towards the purchase of 22 multi-mission Predator Guardian UAVs. Approval of such a major military sale would help in "sealing the Indian-US defence relationship" and bring in "a new level of comfort" between the two militaries.

The Indian armed forces presently operate a variety of UAVs, mostly of Israeli origin, including Herons and Searchers even as DRDO is developing an indigenous system, the Rustom II, which eventually would be armed with precision-guided missiles. Meanwhile, ostensibly with Chinese assistance, Pakistan has developed its Burraq armed UAV, equipped with the Barq air-to-surface missile, which have been deployed for operations in North Waziristan.

India-Sweden Defence & Aerospace Seminar

So as to deepen Indo-Swedish defence and aerospace cooperation, the Government of India has urged Swedish companies to forge large-scale partnerships with Indian manufacturers and reap 'early bird' advantages from the amended defence procurement rules (*see Vayu IV/2016*). The policy gives priority to indigenously designed, developed and manufactured defence equipment. To take the process forward, FICCI in collaboration with SOFF (the Swedish Security and Defence Industry Association) and the Swedish Embassy in India organised the India-Sweden Defence & Aerospace Industry seminar in New Delhi on 31 August.

Addressing the seminar, Sanjay Garg, Joint Secretary (DIP), Ministry of Defence, Government of India, the policy focus was not just on pure manufacturing but in the last two years 85% of the capital acquisition proposals have been appeared under the new category Buy Indian - Indigenously Designed, Developed and Manufactured (IDDM) and Buy and Make (I). Ambassador Anders Bengtcen, Ministry of Foreign Affairs, Sweden, said that there was tremendous scope for collaboration between Swedish and Indian companies in aviation, maritime security and combat training and simulation for army personnel. "Swedish companies are here for a long haul and this was possible because of the trust and reliability that they enjoy," he added.

Mirage 2000 I achieves FOC

The first upgraded Mirage 2000 fighter in Final Operational Configuration (FOC) completed by HAL, made its first flight on 28 July 2016, meeting planned programme timelines. The 45-minute flight was piloted by Gp Capt C Subramaniam (Retd), Chief Test Pilot at HAL and Wg Cdr Haldikar of ASTE. The Final Operational Configuration (FOC) design was implemented on an

Initial Operational Configuration (IOC) aircraft, which was received at HAL about eight months ago. The initial operation configuration was designed by Dassault and Thales in France, while HAL took up FOC design and development activities, covering integration of Indian-specific weapons, sensors and EW systems. The upgraded Mirages integrate different types of data buses in IOC and FOC specifications, without any degradation. After the initial phase of upgrades was concluded in France, HAL is now responsible for the IOC and FOC upgrade of the entire IAF Mirage 2000 fleet.

MICA firing by IAF Mirage 2000 I

To the IAF's No. 1 Squadron 'Tigers', went the honours of the first successful launch of the MBDA MICA ‹beyond visual range› air-to-air missile. This was against a manoeuvring target from a Mirage-2000 I upgraded aircraft. The missile achieved a direct hit on the target, which was much smaller than an actual aircraft and flying at low altitude. The target was destroyed on

File photo of an RF MICA. It is not known which version was launched by the IAF Mirage 2000(I)

missile impact, validating launch envelope of the missile. India purchased 450 MICAs from MBDA as part of the Mirage 2000 upgrade deal from France in 2012 for $1.23 billion. The MICA comes in two versions: RF MICA (with radar seeker providing all weather shoot-up / shoot down capability) and IR MICA (with dual waveband imaging infrared seeker surpassing latest generation AAM missiles).

Pasighat ALG operational

The upgraded Advanced Landing Ground (ALG) at Pasighat in Arunachal Pradesh was inaugurated on 19 August, the event also attended by Air Marshal C Hari Kumar, AOC-in-C Eastern Air Command.

Thereafter, a formation of three Su-30MKIs from an EAC air base conducted a flypast over Pasighat, followed by a Su-30MKI making the first fighter landing at this ALG. The upgrades include runway re-surfacing, and installation of infrastructure such as concrete aprons for ground manoeuvring, an ATC tower, perimeter access road and a security wall, allowing operations of a range of fixed wing aircraft as well as helicopters.

Meanwhile, the Airports Authority of India is in process of setting up a civil terminal at Pasighat, to take advantage of the improvements initiated by the IAF in 2010. Prior to that, the ALG at Pasighat was small strip that was partly paved, partly grass, and reinforced with perforated steel plates, utilised for sporadic air maintenance sorties and casualty evacuation by the IAF. The IAF has eight ALGs in the state, at an overall outlay of nearly Rs 1,000 crore. The ALGs at Walong, Ziro, Along, Mechuka and Pasighat have since been upgraded, with ALGs at Tuting and Tawang expected to be ready by end-2016, and work on the ALG at Vijaynagar will shortly commence.

HAL's Light Utility Helicopter in maiden flight

HAL conducted the first 'technical flight' of its Light Utility Helicopter (LUH) at Bangalore on 6 September. The prototype (PT1, tail number ZG4620), piloted by HAL test pilots Wg Cdr Unni Pillai and Wg Cdr Anil Bhambari, was airborne for 15 minutes. This significant milestone marks the beginning of the flight test campaign, which will eventually involve three prototypes and is intended for completion by end-2017. The LUH is HAL's third indigenous helicopter after the Dhruv ALH and the Light Combat Helicopter (LCH).

The LUH is a single-engine derivative of the Dhruv, incorporating a single-engine variant of the Shakti engine, Safran's Ardiden 1U of 1,400shp (picture on page 23). The LUH has a maximum All-Up Weight (AUW) of 3,150 kg, with a range of 350 km, service ceiling of 6,500 metres and seating capacity for six passengers (plus two pilots).

The LUH is intended to replace the large number of Cheetah and Chetak light helicopters in service with all three aviation branches of the Armed Forces.

LCH TD-1 with indigenous IADS

The Integrated Architecture and Display System (IADS) indigenously developed jointly by HAL's Mission and Combat System R&D Centre (MCSRDC) and Rotary Wing R&D Centre (RWRDC) has been integrated on the first LCH prototype (TD-1), ZP4601, with first flight carried out on 16 July 2016 at Bangalore, with Wg Cdr Unni K Pillai and Wg Cdr Anil Bhambani at the controls.

IADS consists of four Line-Replaceable Units (LRUs): the Display Mission Computer (DMC), Control and Display Unit (CDU), Data Interface Unit (DIU) and Multi-Function Display (MFD). The software and DMC are developed by MCSRDC, which is designated as the primary R&D centre for the project. The other hardware (CDU, DIU and MFD) is developed by Accord Software and Systems Private Limited, S-Wave Systems Private Limited and Samtel-HAL Display Systems, making all IADS hardware and software development fully indigenous. Dhruv ALH MFDs are being used for the initial test flights.

MoD to procure 45 bird-detecting radars

Increasing habitation around airports and air bases and unregulated waste disposal are making bird strikes responsible for over 25 per cent of aircraft accidents in the country. To address this, the Ministry of Defence is set to procure bird-detection radars that will detect and track avian activity in the vicinity of military airfields. The MoD has projected a requirement of 45 Bird Detection and Monitoring Radar Systems to mitigate risk to flight safety.

The MoD is seeking radars that are deployable at all altitudes across India and will be able to withstand weather conditions encountered across the country, according to a Request For Information (RFI) issued in September. Besides being road-mobile, the system should be able to detect large birds at a distance of 11 km and small birds up to 6 km, with a large screen to display the air situation picture.

Ka-28 ASW helicopters to be upgraded

On 30 July, the Indian MoD signed a Rs 2,000 crore contract with Russia's Rosoboronexport to upgrade and extend the life of the Indian Navy's obsolescent Kamov Ka-28 ASW helicopters. The upgrade will see structural work on the ten helicopters being carried out at Kumertau in Russia, before they are moved to Visakhapatnam where they will be outfitted with modern sensors of Western origin.

Army helicopter maintenance hub in Haryana

The Indian Army is to set up a maintenance and overhaul base for Army Aviation Corps (AAC) helicopters in Haryana, and has sought allocation of land for the purpose from the State Government. Although the Army requested 40 acres of land near Pinjore, the state government has suggested Hissar, some 150 km from Delhi and 340 km from Chandigarh, where an integrated aviation hub is envisioned.

The bulk of the AAC's helicopter fleet is based in Jammu & Kashmir, Punjab and Rajasthan, and comprises entirely HAL-built rotorcraft such as the Dhruv, Rudra, Chetak and Cheetah which presently are sent to Bangalore for major repairs and overhaul. The Army believes it will be operationally and logistically advantageous to have a maintenance and overhaul hub closer to where the helicopters are operated.

Modified Mi-17V-5s for VIP transport

After the AgustaWestland imbroglio left the IAF without a VIP helicopter fleet, an alternative has been to modify Mi-17V-5 medium-lift utility helicopters, a number of these being worked on by the No.3 Base Repair Depot (3 BRD) in Chandigarh. The modified helicopters incorporate air-conditioning and soundproofing of the passenger cabin, VIP passenger seats, provisions for a small toilet and requisite security, communications and safety equipment. The project commenced last year and the modified rotorcraft are now certified for VIP transport by the Regional Centre for Military Airworthiness (RCMA), Chandigarh.

These helicopters are to join the Air Headquarters Communication Squadron based at Palam Air Force Station in Delhi, replacing older Mi-8PS VIP helicopters.

Increased financial powers for Army Commanders

Under amended rules, the *Delegation of Financial Powers to Defence Services 2016* -has been notified in early September 2016, the 182 page document detailing the manner in which funds can be spent, both with IFA and without IFA consultation. This delegation will largely apply to the Army, whose GoC-in-C Northern Command will have an amount of Rs 400 crore, his Eastern counterpart Rs 200 crore (essentially covering Special clothing and equipment for extreme climatic conditions) while the other Army Commanders will have a ceiling of Rs 50 crore.

IAF seeking 'smart' airfield security

The Indian Air Force is examining various options for a new 'smart airfield protection system', eight months after the attack on Pathankot Air Force Station exposed several vulnerabilities in perimeter security. The IAF will initially carry out a pilot project at a selected Western Air Command base, incorporating systems such as a 'smart fence', surveillance systems, thermal cameras, motion detectors and a command centre to monitor all these sensors.

A security audit following the Pathankot attack has led the IAF to estimate that it will need to spend over $1 billion for securing its air bases, with upgraded defences required for at least 54 major facilities. Western Air Command has asked Indian companies to bid for the pilot project, which will then be replicated at bases across the nation.

Indian Defence support to Afghanistan

During his two-days visit to New Delhi 14-16 September, Afghan President Ashraf Ghani and Indian Prime Minister Narendra Modi denounced the sponsorship of terror in the region and vowed to further deepen bilateral cooperation, India also pledged $1 billion for the support and development of "a unified, sovereign, democratic, peaceful, stable and prosperous Afghanistan."

"Stressing that elimination of all forms of terrorism, without any discrimination, is essential, they called upon the concerned to put an end to all sponsorship, support, safe havens and sanctuaries to terrorists, including for those who target Afghanistan and

India," read a joint statement issued by the two leaders, who reaffirmed their resolve to counter terrorism and strengthen security and defence cooperation as envisaged in the India-Afghanistan Strategic Partnership Agreement. The two sides also discussed quick implementation of the trilateral agreement regarding Chabahar Port and involving Afghanistan, India and Iran, which was signed in May 2016. India and Afghanistan also signed an Extradition Treaty, an agreement on cooperation in civil and commercial matters and a memorandum of understanding (MoU) on cooperation in peaceful use of outer space.

In a major strategic move, the Government of India is likely to also assume security provision to Afghanistan, a marked shift from having earlier given major support in development areas including building of roads, power projects, hospitals, educational institutions and so on. During Afghan President Ashraf Ghani's visit to New Delhi in mid-September, India has reportedly agreed to consider supply of military equipment and platforms to meet Afghanistan's requirements. It is likely that more Russian-origin Mi-25 combat helicopters beyond the first four will be provided by India as also a range of weaponry for the ground forces. The two countries also signed three pacts which include the Mutual Legal Assistance Treaty, an extradition treaty and an agreement on the peaceful uses of outer space.

Small arms export restrictions tweaked

The revised Arms Rules 2016, notified by the government in July, have clarified private sector participation in small arms manufacturing, foreign investment and sales and exports. Until now, only public sector companies produced arms for the Indian military, but with massive annual requirements across the services, large quantities of small arms continued to be imported.

The revised rules not only enable the private sector to help meet domestic demand but also to enter the export market. Since small arms are now under the defence ambit, this also opens the way for automatic FDI investments up to 49 per cent in the sector. Several major foreign manufacturers are understood to be in advanced talks with Indian companies to set up facilities following these regulatory changes. The new rules will grant Indian companies licences after due vetting, allow them access to SEZs and will enable exports, "subject to the approval of the Ministry of Home Affairs in consultation with the Ministry of External Affairs, Ministry of Defence and Ministry of Commerce, on a case to case basis."

India and Myanmar enhance bilateral ties

During the state visit of the Myanmar President U Htin Kyaw to India 27-30 August, the two countries signed four MoUs on infrastructure, energy and medicine, and vowed "to enhance bilateral relations and cooperate to combat terrorism". Indian PM Narendra Modi acknowledged that President U Htin Kyaw had chosen India for his first bilateral state visit, and agreed on "the need to remain sensitive to each other's strategic interests and concerns." He also highlighted that "India's nearly $2 billion development assistance is touching the lives of the common man in Myanmar."

India boosts Vietnam defence ties with $500 million credit line

The Government of India has extended a $500 million line of credit to Vietnam "to deepen defence cooperation", signing 12 agreements including construction of offshore patrol boats. PM Narendra Modi, making his first visit to Vietnam, held wide-ranging talks with his Vietnamese counterpart Nguyen Xuan Phuc in Hanoi and said that the two countries have decided to elevate their strategic ties to a Comprehensive Strategic Partnership to provide it a new momentum. Vietnam has previously had Comprehensive Strategic Partnerships only with Russia and China.

The agreements signed covered a wide range of areas including defence, IT, space, cyber security and white shipping information. PM Modi described the talks with his Vietnamese counterpart as "extensive and very productive" and said that they covered the full range of bilateral and multilateral cooperation. "As two important countries in this region, we feel it necessary to further our ties on regional and international issues of common concern," said Modi.

China warns India off SCS disputes

Ahead of Chinese Foreign Minister Wang Yi's visit to New Delhi on mid-August, leading editorial in China warned India to avoid "unnecessary entanglement" in the South China Sea dispute, to prevent it becoming "another factor" that impacts bilateral ties.

"India may want to avoid unnecessary entanglement with China over the South China Sea debate during Wang's visit if the country wishes to create a good atmosphere for economic cooperation, which would include reducing tariffs on made-in-India products exported to China amid the ongoing free trade talk known as the Regional Comprehensive Economic Partnership".

DAC clears C-130J attrition replacement

The Defence Acquisition Council (DAC), chaired by Defence Minister Manohar Parrikar, has approved procurement of one Lockheed Martin C-130J Super Hercules special missions aircraft, (for approximately $135 million), as an attrition replacement for the No.77 Squadron aircraft that had crashed during a low-level training sortie in March 2014 (seen in the picture). The IAF originally inducted six C-130J Super Hercules aircraft in 2010, and a follow on order for an additional six, to be delivered in 2017, was cleared in 2013. Discussions for an attrition replacement began shortly after the 2014 crash, and in February 2014, the DAC had

first cleared procurement of a replacement (*see Vayu II/2015*) at a cost of Rs 533 crore. It is unclear what necessitated fresh clearance for this purchase over a year later, at a major cost increase.

50th C-130J Super Hercules empennage from Tata-Lockheed Martin JV

The 50th C-130J Super Hercules empennage assembly was delivered by Tata Lockheed Martin Aerostructures Limited (TLMAL) on 16 September. TLMAL was established in 2010, with production of C-130J Super Hercules airframe components beginning in late 2011, and has the distinction of being the single global source of C-130J empennage assemblies included on all new Super Hercules aircraft produced in Marietta, Georgia, in the USA.

Empennage assemblies produced by TLMAL include the aircraft's horizontal and vertical stabilisers along with leading edges and tip assemblies. The TLMAL team also has manufactured 28 sets of C-130J center wing box components that include the front and rear beam assemblies, formers and trailing edge sections. To date, all 50 empennages and 28 center wing box components have been delivered on or ahead of schedule.

BEL's new factory at Nimmaluru

On 19 September, the foundations stone was laid for Bharat Electronics Limited (BEL)'s Advanced Night Vision Products Factory at Nimmaluru Village, near Machilipatnam in Krishna District of Andhra Pradesh. The largest such facility in the country once it is commissioned, this will cover an area of over 50 acres and is some 16 Km from the existing Unit of BEL at Machilipatnam.

As Mr SK Sharma, Chairman & Managing Director, BEL, said: "Bharat Electronics has been continuously engaged in design, development and manufacturing of Electro Optics equipment and Night Vision Products for defence and paramilitary forces. The new facility has been planned now to establish a state-of-the-art factory to cater to the futuristic requirements for Night Vision Products."

TAL ships 5000th floor beam for 787 Dreamliners

Indian Government officials and Boeing executives at the Nagpur event

TAL Manufacturing Solutions Ltd. (TAL), a subsidiary of Tata Motors, has despatched the 5000th Advanced Composite Floor Beam (ACFB) to Boeing for the 787 Dreamliner airliner. The event was celebrated at a flag-off ceremony on 20 August at TAL's manufacturing facility located in MIHAN SEZ, Nagpur. TAL is the only non-US facility to supply the ACFB to Boeing for the 787-9 Dreamliner and will supply this component to the new soon-to-be-built 787-10 Dreamliner. ACFBs are shipped to Boeing partners in Italy, Japan and the United States.

Boeing India President, Pratyush Kumar called this a major milestone not just for Boeing and TAL but also for India. "This is not just any part," said Kumar "It represents a highly advanced form of composite manufacturing that enhances India's stature in the global supply-chain network of Boeing. This is an excellent example of India bringing value to Boeing, and Boeing bringing cutting-edge technology to India – a truly win-win partnership."

CIM Tools gets Boeing contract

Boeing has announced a contract to CIM Tools Private Ltd of Bangalore for the manufacture of complex titanium machined parts and aluminium assemblies for the 787 Dreamliner and 737 aircraft. Under the contract, CIM Tools will supply over 57,000 complex titanium machined parts, aluminium details, and assemblies for Boeing 787 and 737 airliners in coming years. CIM Tools is one of the Micro Small and Medium Enterprises (MSME) in India that Boeing is directly working with, "in line with Boeing's strategy in India to develop an indigenous aerospace and defence ecosystem to further support the 'Make in India' initiative".

Ashwani Bhargava, director of Supplier Management, Boeing India and Srikanth GS, director of Business Development & Finance, CIM Tools, sign the contract in Bangalore

Phase IV production of Su-30MKI Multi-Channel Power Drive

HAL's Accessories Division in Lucknow has produced the first phase-IV (from raw materials) unit of the Multi-Channel Power Drive SPM6B for the Su-30 MKI. This allows movement of the tail plane as per electric signals given by the fly-by-wire computer through the four-channel control system of the aircraft. The operation of the Multi-Channel Power Drive is carried out from two independent hydraulic systems of the aircraft. SPM6B production includes a total machining time of 3,342 hours and assembly of 396 parts. Testing is done at various test stations and includes validation at temperatures ranging from -60 degrees Celsius to +105 degree Celsius.

Javelin JV with Tata Power

The Javelin Joint Venture team, a partnership between Raytheon and Lockheed Martin, signed a letter of intent (LoI) with Tata Power, operating through its Strategic Engineering Division (SED), to explore co-development and production of the Javelin anti-armour missile system. "This agreement brings together three

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world leaders in aerospace and defence technology to extend Javelin to new customers, new applications and new platforms," said John Halvey, Javelin Joint Venture president at Raytheon Missile Systems. "With this deal, we are also reinforcing our continued support of the 'Make in India' initiative."

As part of the LOI, the Javelin Joint Venture (JJV) and Tata Power SED will create a strategy to co-develop and produce the Javelin missile system and integrate platform mounts to meet Indian requirements. This includes ground combat vehicle, dismounted infantry and rotorcraft applications. The LOI also establishes a framework for future technological cooperation between the Javelin Joint Venture and Tata Power SED.

Tata Advanced Materials panels for Boeing P-8

Tata Advanced Materials Limited (TAML), a subsidiary of Tata Industries Limited, has been awarded a contract from Boeing to provide composite interior closeout panels that cover the interior wall structure of the P-8 aircraft. The P-8, operated by the Indian Navy as the P-8I, is operated for long-range anti-submarine and anti-surface warfare, as well as armed intelligence, surveillance and reconnaissance missions. The contract, signed in September 2016, will strengthen TAML's position in the aerostructures segment, and reinforce the 'Make in India' initiative. TAML is already under contract to manufacture the P-8 tail cone and auxiliary power unit door fairing in India.

Zen Technologies exports to Egypt

Zen Technologies has announced an export order worth about Rs 30 crores, from the Egyptian Ministry of Defence having selected Zen Technologies to provide range of training equipment including Smart Target Systems. Ashok Atluri, CMD, Zen Technologies said, "Zen Technologies has over the years emerged as a strong player in the field of defence training simulation in India and it has been our endeavour to expand our presence abroad – specifically the Middle East and African region. The order from the Egyptian Government is a reflection of our commitment towards

providing the best training tools to security forces to tackle and neutralise both external and internal threats.

ISRO's scramjet engine tech demonstrated

The first experimental mission of ISRO's Scramjet (Supersonic Combustion Ramjet) Engine was successfully conducted on 28 August 2016 from the Satish Dhawan Space Centre, Sriharikota. After a smooth countdown of 12 hours, a solid rocket booster carrying two Scramjet Engines, lifted off and thereafter Key flight events, including burn out of the booster stage, ignition of the second stage solid rocket, functioning of scramjet engines for 5 seconds, followed by burn out of the second stage took place as planned.

After a flight of about 300 seconds, during which the test engines experienced speeds of approximately Mach 6, the vehicle splashed down in the Bay of Bengal, some 320 km from Sriharikota.

The test successfully demonstrated critical technologies such as ignition of the air breathing engines at supersonic speed, holding the combustion flame at supersonic speed, air intake mechanism and fuel injection systems. The Scramjet engine designed by ISRO uses Hydrogen as fuel and Oxygen from atmospheric air as the oxidiser. The 28 August test was the maiden short duration experimental flight of ISRO's scramjet, making India the fourth country to demonstrate flight-testing of a scramjet engine.

Record profits for SpiceJet

SpiceJet has reported a net profit of Rs 149 crore for the first quarter of 2016-17 financial year, as against Rs. 73 crore for the same quarter last year, an improvement of 104%. Capacity deployed registered a growth of 37% over the same quarter last year and operating revenue was Rs 1,522 crores, a growth of 37%. This is the sixth consecutive profitable quarter for SpiceJet after changes in management and control at the Company in December 2014.

The airline also recorded a passenger load factor of 92.5% in Q1, the highest in the industry, as well as improved on time performance and low cancellations rates for SpiceJet flights. "This quarter's results further demonstrate the impact of efforts that are being put into strengthening SpiceJet," said Ajay Singh, Chairman & Managing Director, Spicejet Limited. "We remain focused on growing responsibly in a growing but a challenging market."

Air India launches transatlantic Dreamliner route

On 15 August, Air India launched its first transatlantic route operated by the Boeing 787-8 Dreamliner, with Flight 171 taking off from Ahmedabad to London, before heading onward to Newark, New Jersey. The airline is aiming at the large Gujarati community in the New York and New Jersey areas to make the route economically sustainable. Operationally, the airline had to provide its pilots special training to operate the Dreamliner's first transatlantic flights in AI service.

Indian carriers request "avoidance of Pakistani airspace"

Indian carriers are reportedly seeking the Government's clearance to fly to the Gulf from western India directly over the Arabian Sea to avoid the circuitous route over Pakistan. Security fears due to deteriorating India-Pakistan ties as well as economic factors are understood to be behind such requests. Air India, Jet Airways, IndiGo and SpiceJet operate flights to the Gulf over Pakistan. SpiceJet has sought direct access for its flights from Ahmedabad to the Gulf under the "flexi-use of airspace" provision, which allows commercial aircraft to use airspace reserved for the IAF and Navy, with estimated savings of Rs 100,000 per flight if allowed a direct oceanic route for its Ahmedabad-Dubai flight.

Aircraft for Punjab flying clubs

Flying clubs in Punjab are to get new aircraft after some 50 years, with the Punjab government finalising a Rs 8.5 crore order for three new aircraft, being two Cessna 172S, plus one twin-engined Tecnam P2006T. Purchased with the financial aid provided by the state government in March last year, all three new aircraft will train commercial pilots at flying clubs in Amritsar, Patiala and Ludhiana.

India and Russia negotiate for 4 stealth frigates

A high level *India-Russia Military Technical Cooperation Working Group* (MTC-WG) meeting took place in New Delhi on 7 September 2016 wherein various 'mega defence projects' were discussed including the Indian Navy's requirement for four more stealth frigates for around $4 billion. It is proposed that while two of the *Teg* or *Grigorovich*-class frigates will be supplied from Russia, another two will be constructed in Indian shipyard.

There will supplement the six Russian-origin stealth frigates already serving with the Indian Navy, the first of three *Talwar*-class frigates being inducted in 2003-04, followed by three *Teg*-class ships under an $1.15 billion contract in 2006. Meanwhile, the Indian Navy is receiving indigenous-developed and built stealth frigates, essentially those of the *Shivalik*-class while the construction of seven more stealth frigates under 'Project 17A' was formalised in February 2015. Four of these are being built at Mazagaon Docks, Bombay and three at GRSE in Calcutta.

With some 130 warship and 235 aircraft in its current inventory, the Indian Navy plans a 150 warship Navy (with essentially more modern craft) and a commensurate increase in aircraft numbers by 2027 "to meet its responsibilities to the large geo-strategic arc from the Persian Gulf to the South China Sea".

MDL launches second Project 15B destroyer

On 17 September 2016, Mazagon Dock Shipbuilders Limited (MDL) launched Yard 12705, the second vessel of Project 15B (*Visakhapatnam*-class stealth destroyers). The ship will be named INS *Mormugao* in service, and was launched ahead of schedule, with Admiral Sunil Lanba, Chief of Naval Staff present as chief guest for the occasion.

The *Visakhpatnam*-class destroyers are a follow on to the three-ship *Kolkata*-class (Project 15A), of which two (INS *Kolkata* and *Kochi*) are already in service, with the third (INS *Chennai*) due to be commissioned this year. The first Project 15B ship, Yard 12704, to be christened INS *Visakhapatnam* in service, was launched in April 2015.

Russian rescue ship *Igor Belousov* at Visakhapatnam

Russian Naval Rescue Ship *Igor Belousov* visited Visakhapatnam in early August 2016 on a four-day visit to the Eastern Naval Command. The Russian Commanding Officers called on Rear Admiral SV Bhokare, FOC Eastern Fleet and Rear Admiral Sanjay Mahindru, Flag Officer Submarines. The rescue ship *Igor Belousov* is of particular interest to the Indian Navy, as the Navy presently possesses no deep sea rescue capability – a shortfall that will be more keenly felt once nuclear submarines are inducted and begin long-range patrols far from Indian shores.

ICGS *Sarathi* commissioned

Indian Coast Guard Ship *Sarathi*, third in a series of six *Samarth*-class Offshore Patrol Vessels (OPVs) being built for the Coast Guard, was commissioned at Goa by Home Minister Rajnath Singh on 9 September, in the presence of ICG Director General Rajendra Singh, CMD Goa Shipyard Limited and other dignitaries from the

Central and State Governments. On joining the Coast Guard fleet, ICGS *Sarathi* will be based at Kochi and will form part of the Naval Training Squadron.

Ships of the class are 105 metres long with a displacement of 2,350 tonnes, and feature Integrated Bridge System (IBS), Integrated Machinery Control System (IMCS), Power Management System (PMS) and High Power External Fire Fighting System. They are designed to carry one twin-engine light helicopter and five high-speed boats for fast boarding operations, search and rescue, law enforcement and maritime patrol. The class is also capable of carrying pollution response equipment to combat oil spill contamination at sea.

Japan to revive Shinmaywa US-2 negotiations

Japanese defence ministry officials have indicated that they would consider reducing the price of 12 Shinmaywa US-2 amphibians on offer to India as part of an attempt to revive negotiations, valued at around $ 1.6 billion. Japanese sources highlighted that the sale was important not just for economic reasons but because Japan considers India "a friendly country".

An agreement on the amphibians would have tremendous symbolic significance as a message to China about deepening defence and security cooperation between India and Japan, and it is now hoped that there will be progress in talks by the time PM Narendra Modi visits Tokyo later in 2016 for the annual summit meet between the leaders of the two nations.

GSLV Launches INSAT-3DR

In its tenth flight (GSLV-F05) conducted on 8 September 2016, India's Geosynchronous Satellite Launch Vehicle, equipped with the indigenous Cryogenic Upper Stage (CUS), successfully launched the country's weather satellite INSAT-3DR, into a Geosynchronous Transfer Orbit (GTO). The launch took place from the Second Launch Pad at the Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota, the spaceport of India. This was the first operational flight of GSLV equipped with CUS and the fourth to carry the indigenous CUS. This GSLV flight was the third consecutive success achieved by GSLV carrying indigenous CUS and the 2211 kg INSAT-3DR is the heaviest satellite to be launched from the Indian soil.

Soon after its injection into GTO, the solar array of INSAT-3DR was automatically deployed and the Master Control Facility (MCF) at Hassan in Karnataka took control of the satellite. Like its predecessor INSAT-3D which is providing service from orbit since 2013, INSAT-3DR is an advanced meteorological (weather observation) satellite built by India to provide a variety inputs essential for accurate weather forecasting. For this, it is equipped with three payloads (instruments), namely, a multispectral imager, sounder and weather data relay transponder. INSAT-3DR also carries a satellite aided search and rescue transponder that picks up and relays alert signals originating from distress beacons of maritime, aviation and land based users.

APPOINTMENTS

Lt Gen Bipin Rawat takes over as VCOAS

With Lt Gen MMS Rai retiring on 31 August, the post of Vice Chief of the Army Staff (VCOAS) has been assumed by Lt Gen Bipin Rawat, on 1 September 2016. Lt Gen Rawat was commissioned in the 11 Gorkha Rifles in December 1978 from IMA, Dehra Dun, where he was awarded the 'Sword of Honour.' He has vast experience in high altitude warfare and counter insurgency operations, commanded an Infantry battalion along the Line of Actual Control (LAC) in the Eastern Sector, a Rashtriya Rifles Sector and an Infantry Division in the Kashmir Valley.

Lt Gen Rawat has also held important staff appointments at the Directorate General of Military Operations and Military Secretary's Branch at Army HQ. The officer commanded a Multinational Brigade in the Democratic Republic of the Congo (MONUC). Prior to taking over as the VCOAS, Lt Gen Bipin Rawat was GOC-in-C Southern Command.

Lt Gen Surinder Singh is GOC-in-C Western Command

Lieutenant General Surinder Singh has been appointed GOC-in-C Western Command after the outgoing Western Command Chief, Lt Gen KJ Singh, retired on 31 July. The official appointment was made on 15 September 2016 by the Ministry of Defence, however, the 'delay' in announcement was not clarified. Commissioned in 1979 in the Brigade of Guards, Lt Gen Surinder Singh has commanded a Guards Battalion (mechanised), an Armoured Brigade and an Infantry Division. His previous appointment was General Officer Commanding of XXXIII Corps in Northern Bengal, headquartered in the strategic Dooars corridor.

Lt Gen DR Soni is GOC-in-C ARTRAC

Lt Gen DR Soni was also commissioned in 1979 into the Central India Horse Regiment and has later commanded an armoured regiment, armoured brigade and the 1st Armoured Division. Earlier, he was GOC of Bathinda-based X Corps. He takes over the Command of ARTRAC in Shimla after Lt Gen PM Hariz, the previous incumbent, was moved as GOC-in-C Southern Command in Pune.

General PM Hariz takes over Southern Command

Lieutenant General PM Hariz has become General Officer Commanding-in-Chief Southern Command prior to which he was GOC-in-C Army Training Command at Shimla. Lieutenant General Hariz was commissioned into 12 Mechanised Infantry Battalion in 1978 and has the unique distinction of holding various UN appointments, has commanded a Battalion, Brigade, Division and Corps in the Western Sector and has been on staff appointments at various levels at Integrated Headquarters (Army) in New Delhi.

BEL CMD named "Most Enterprising CEO"

BEL Chairman and Managing Director SK Sharma has been awarded the Most Enterprising CEO in the Electronics Sector by the Indo Global Business Council (IGBC), a policy think tank based in New Delhi. MM Joshi, Executive Director (National Marketing), BEL, received the award on behalf of the CMD at an award function held in Delhi in August.

Air Marshal HS Arora is Director General (Air Operations)

Air Marshal Harjit Singh Arora took over as Director General Air (Operations) on 26 August 2016. The Air Marshal was commissioned in the IAF as a fighter pilot in December 1981, and has over 2,600 operational flying hours on MiG-21s, MiG-29s and other IAF aircraft, including helicopters. He has served as Directing Staff at TACDE and as a Flying Inspector in the Directorate of Air Staff Inspection (DASI).

He commanded No.45 Squadron 'Flying Daggers' ADDC Commander and Station Commander at 33 Signals Unit, 'The Scanners.' Later he commanded Air Force Station Adampur and as Air Vice Marshal was Air Defence Commander at HQ Western Air Command as well as Eastern Air Command.

Air Marshal B Suresh appointed AOP

Air Marshal B Suresh assumed charge as Air Officer-in-Charge Personnel (AOP) at Air Headquarters on 31 August. A graduate of the RIMC, Dehra Dun and National Defence Academy, Khadakvasla, the Air Marshal was commissioned as a fighter pilot in the Indian Air Force in December 1980, is a graduate of the Tactics and Air Combat Development Establishment (TACDE), a graduate of the Defence Services Staff College, Wellington, and a post-graduate from Cranfield University, UK. He commanded No.2 Squadron, 'The Winged Arrows,' as a Wing Commander, TACDE as a Group Captain and a strategic fighter base as an Air Commodore.

He has held a number of staff appointments, including Joint Director and Director (Air Staff Inspection), Director Operations (Joint Planning), Directing Staff (TACDE), Air Assistant to Chief of Air Staff, Assistant Chief of Air Staff Operations (Air Defence) and Senior Air Staff Officer, Western Air Command.

VSR Murthy is ADG Coast Guard

ADG VSR Murthy was appointed Additional Director General at Coast Guard Headquarters, New Delhi on 12 August 2016. ADG Murthy joined Coast Guard in January 1984 and has held various important command and staff appointments, both afloat and ashore. He has commanded all four major ship-classes of Indian Coast Guard and his key staff assignments includes Principal Director (Policy & Plans) and Joint Director (Human Resource Development) at Coast Guard Headquarters, New Delhi and Chief Staff Officer (Personnel & Administration) at the Coast Guard Regional (West), Mumbai. He has also commanded two operational commands as COMCG of Coast Guard Region (A&N), Port Blair and Coast Guard Region (North East), Kolkata.

Air Marshal Jasbir Walia is C-in-C Strategic Forces Command

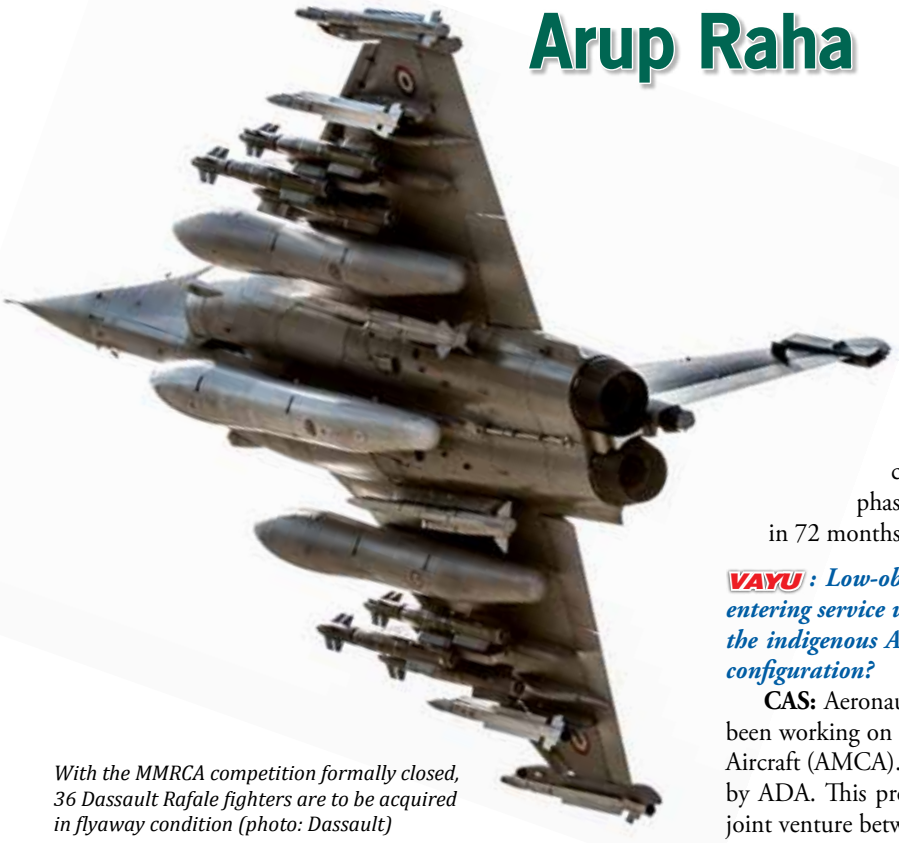
Air Marshal Jasbir Singh Walia assumed charge of the Strategic Forces Command on 1 August 2016, taking over from Lt Gen Amit Sharma. The Air Marshal is an alumnus of the National Defence Academy, Khadakwasla, Defence Services Staff College, Wellington and Air War College, USA. A Qualified Flying Instructor, Pilot Attack Instructor and Fighter Combat Leader, he has vast operational experience in the fighter stream of the Indian Air Force.

In his 37-year career, the Air Marshal has held various staff and operational assignments. He has commanded a frontline fighter squadron, an operational air base and Headquarters, Jammu & Kashmir Area and was also Air Attaché in Washington DC. The Air Marshal was AOC-in-C Southern Air Command prior to taking over Strategic Forces Command.

The IAF at 84

VAYU Interview with

Air Chief Marshal Arup Raha



With the MMRCA competition formally closed, 36 Dassault Rafale fighters are to be acquired in flyaway condition (photo: Dassault)

***VAYU**: There is understandable concern on the steadily depleting combat aircraft strength of the IAF. Under the original MMRCA plan, 126 Rafales were to be acquired, later pruned to 36 but even this has not fructified. What is the status of this critical procurement?*

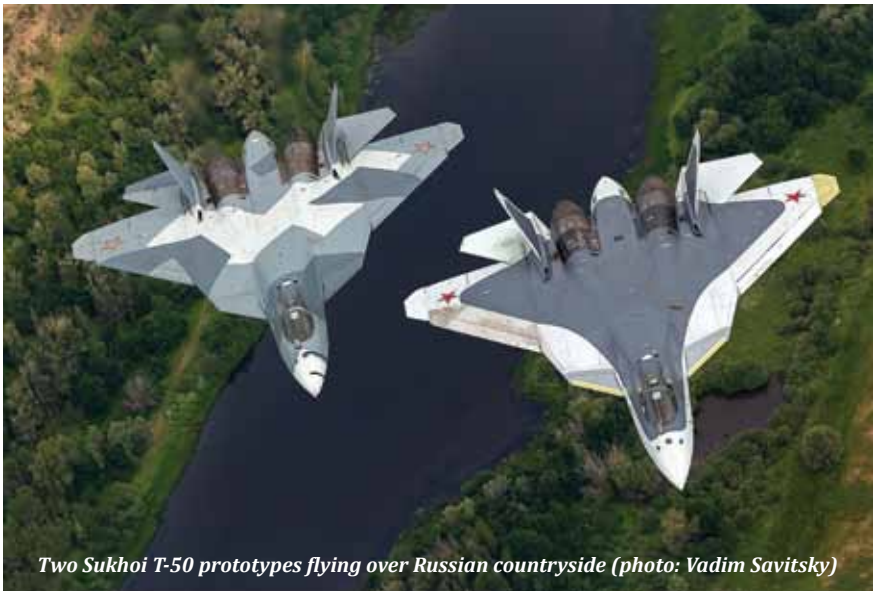
CAS: The procurement of 36 Rafale aircraft is likely to fructify shortly. Various options are being considered by MoD to build up the strength of combat aircraft in the IAF. **The Air Chief was correct, as the Rafale Agreement was signed mere days after this interview !– Ed.**

***VAYU**: The Fifth Generation Fighter Aircraft, to be developed in collaboration with Russia, remains uncertain owing to various factors. Please indicate the envisaged time-frame for this programme.*

CAS: The negotiations for Research and Development (R&D) contract have been concluded by both the sides. The draft R&D contract is being processed for approval. The R&D phase for the development of FGFA is to be completed in 72 months.

***VAYU**: Low-observable, fifth-generation fighters are close to entering service with the Chinese PLAAF. What is the status of the indigenous AMCA project, in terms of its desired role and configuration?*

CAS: Aeronautical Development Agency (ADA), DRDO has been working on the development of Advanced Medium Combat Aircraft (AMCA). The project feasibility study has been completed by ADA. This project is in addition to the FGFA programme, a joint venture between HAL and Russia. Since the aircraft is likely



Two Sukhoi T-50 prototypes flying over Russian countryside (photo: Vadim Savitsky)

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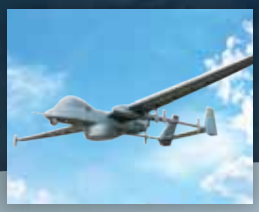

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to be inducted after FGFA, the capabilities of AMCA are expected to be better than that of FGFA. Ideally, the AMCA would be available to replace the upgraded MiG-29, Mirage 2000 and Jaguar fleets in the future.

VAYU: Considering that large numbers of fighter aircraft in the IAF's inventory, such as MiG-21s and MiG-27s, are ageing, production rate of their intended replacement, the Tejas LCA remains an issue, even though the IAF has recently commissioned its first LCA squadron. What is the projected status of the LCA in the IAF, in terms of operational training, infrastructure and logistics support?

A Limited Series Production (LSP) HAL Tejas development aircraft seen during an airshow display (photo: Angad Singh)

CAS: We have started inducting Tejas in the Initial Operational Clearance (IOC) configuration. This is a good beginning and focused developmental efforts are being made to ensure that the Tejas expeditiously meets its envisaged full performance and combat capability. Full performance of Tejas aircraft will be validated during its Final Operational Clearance (FOC), which is planned to be completed shortly. Apart from 20 aircraft each, contracted in IOC and FOC configurations, a fresh case is under process for procurement of additional Tejas Mk.1A aircraft with upgraded avionics suite, operational and maintenance capabilities. The Indian Air Force has been fully involved with ADA and HAL in the development and operationalisation of LCA. Apart from the core team of IAF test pilots and flight test engineers at the National Flight Test Centre (NFTC), a Project Monitoring Team has been based at Bangalore to bridge the gap between designers, manufacturers and the operators. Infrastructure project for the first two LCA squadrons is already under progress.

VAYU: Of late there seems to be an 'unofficial' fighter contest underway, with a number of foreign OEMs proposing a 'Made in India' fighter for the IAF. What is the IAF's input on this process, and how will this impact on planed induction of other aircraft types such as LCA, FGFA, AMCA and Rafale?

CAS: The Ministry of Defence is preparing a road-map for induction of fighter aircraft in the IAF with an aim to build up to the sanctioned strength of 42 fighter squadrons at the earliest. Various options are being considered and manufacturing of an additional type of fighter aircraft under the 'Make in India' initiative is also being actively explored by the Government.

VAYU: The IAF's C-17 fleet is now fully operational and a very visible part of the IAF's HADR outreach around the world. However, recapitalisation of the medium-lift fleet remains mired in some delays. What is the status of the remaining An-32 upgrade aircraft, procurement of an Avro replacement, and development of the Indo-Russian Medium Transport Aircraft (MTA)?

CAS: The Ministry of Defence signed a contract with SpetsTechnoExport of Ukraine on 15 June 2009 for Total Technical Life Extension, Overhaul and Re-equipment of 105 An-32 aircraft held by the Indian Air Force. As per the contract, work on 40 aircraft was to be undertaken in Kiev and the remaining 65 aircraft in India under Transfer of Technology. 40 aircraft have been upgraded at Kyiv and 10 aircraft have been upgraded in India. However, production of aircraft in India has been affected due to delays in supply of spares and upgrade kits. The delay in supply of spares has been taken up at the highest levels as it is affecting production as well as spares availability for fleet sustenance.

The field evaluation trials of Avro replacement aircraft have been completed. The case is progressing well and the contract negotiations are likely to commence soon. The MTA design had certain shortfalls in the envisaged operational capability and techno-commercial viability. Based on these aspects, the project is being reviewed.

The IAF has received its full order of 10 Boeing C-17 Globemaster III heavy airlifters, and is keen to acquire more (photo: Angad Singh)

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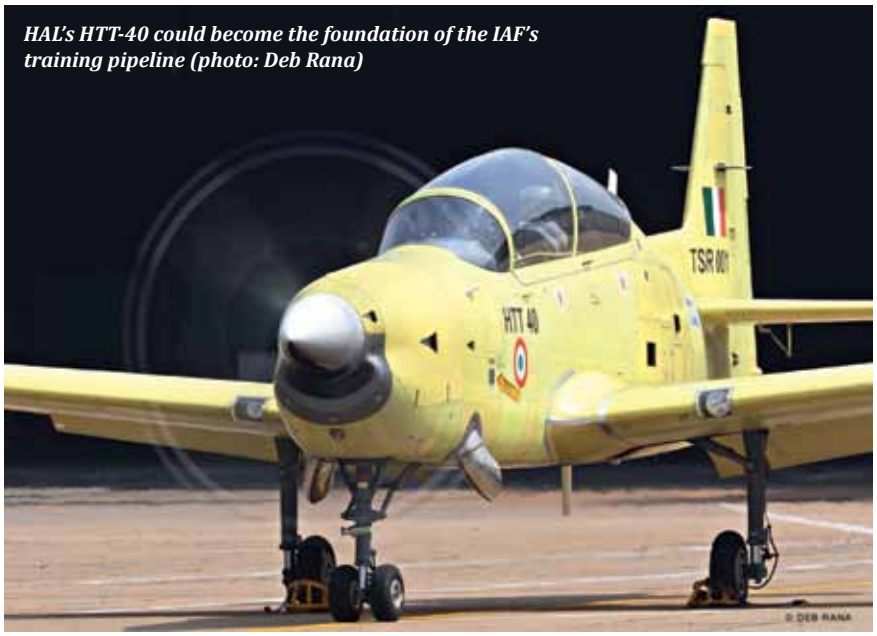
VAYU : The HTT-40 basic trainer made its maiden flight in May 2016, and HAL hopes for the type to enter service in 2018. What is the IAF's support for the programme, and to what degree is monitoring of the project being done so as to avoid situations like those with the LCA and IJT?

CAS: Induction timelines of HTT-40 in IAF will be formulated based on the progress of developmental flight trials. To monitor the progress of HTT-40 project, there exists a Project Monitoring Team at Bangalore.



HAL's HTT-40 could become the foundation of the IAF's training pipeline (photo: Deb Rana)

The team is actively participating in the developmental activities. The lessons learnt by the IAF from the other developmental test programmes are being shared with the HAL design and flight test team. HAL is committed to deliver the aircraft on schedule and IAF is working shoulder to shoulder with HAL for the success of the project.

VAYU : Last year you had stated that "IAF has initiated the process for conducting a flying training pattern based on two aircraft types: PC-7 Mk-II and Hawk AJT, to replace the 'three aircraft – three stages' programme that had so far been in place." How has this process unfolded and does the IAF now no longer seek an Intermediate Jet Trainer (IJT) type aircraft?

CAS: The ab-initio flying training pattern of the IAF was based on a 'three aircraft – three stages' training model : Basic Trainer Aircraft PC-7 Mk.II for Stage-I training, Kiran Mk.I/IA as Intermediate Jet Trainer for Stage-II (Fighter) training and Advanced Jet Trainer Hawk Mk.132 for Stage-III (Fighter) training. Training on Kiran aircraft was to be undertaken on its replacement aircraft, the HAL-built IJT (*HAL HJT-36 Sitara –Ed*), which was to be inducted into the IAF in 2016.

Owing to delays in the Intermediate Jet Trainer project, the IAF had to look for an alternative training pattern. Therefore, the IAF decided to undertake a pilot project based on a 'two aircraft – three stages' model for training of pilots selected for the fighter stream. This model of ab-initio flying training is followed in many Air Forces in the world. In this pilot project, the IAF has utilised PC-7 Mk.II aircraft for flying training of 10 trainees in Stage-II (F). This project would be undertaken for six courses (three years). Presently, two courses have undergone this pattern and the trainees are currently undergoing Stage-III (Fighter) training on Hawk aircraft. Performance of these trainees has been satisfactory so far.

On completion of Stage-III (Fighter) training, pilots would be posted to operational squadrons. Their performance in operational squadrons would need to be evaluated for another three years to assess the efficacy of this pilot project. Based on this evaluation, the pilot project would be extended for a larger strength of trainees. However, to undertake Stage-I training in tandem with Stage-II (Fighter) training on PC-7 Mk.II Basic Trainer Aircraft (BTA), more number of BTA would be required to sustain this pattern of training. If required, after the final review of the scheme, some of the advanced exercises in Stage-II (F) syllabus would be shifted to AJT syllabus.

VAYU : The case for procurement of 20 additional BAE Hawk aircraft to equip the IAF's formation aerobatic team has been proposed for some time. What is an update on this acquisition, even as the re-formed Surya Kiran team gears up for its second Air Force Day display on Hawk Mk.132s?

CAS: At present, the case for procurement of additional 20 Hawk aircraft is at CNC (Contract Negotiation Committee) stage. With the planned increase in pilot intake, the additional Hawk aircraft would help in meeting IAF's enhanced training requirement in Stage-II (F). These aircraft would also help in reviving the Formation Aerobatic Team to showcase IAF's professional competence and image of the country.

The Surya Kiran team currently performs on BAE Systems Hawk Mk.132s, without a smoke generation system (photo: Angad Singh)

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VAYU : While the future of manned combat aircraft is assured for decades yet, in advanced Air Forces, unmanned aircraft are increasingly taking on air-to-ground strike missions, complementing their more usual utilisation as ISR platforms. What is the IAF's future vision for such UCAVs?

CAS: A transition to UCAV platforms would be a natural progression and the IAF is looking at acquisition of such capability. It would be relevant to acquire appropriate precision strike capability by day and night for optimal employment in a variety of theatres including high altitudes and urban terrain. Alongside, it would be relevant to develop indigenous technologies in this regard to augment our offensive strike capability.

VAYU : Proposals to establish a Permanent Chairman of the Chiefs of Staff Committee are once again gaining steam. What is the IAF's stance on the role and establishment of such a post?

CAS: The creation of Permanent Chairman of the Chiefs of Staff Committee is an incremental process and has been supported by the three Services and other agencies. As per the Naresh Chandra Task Force's recommendations, the Permanent Chairman of the Chiefs of Staff Committee would be the single point contact between the Government and the three Services. He would thus be a fourth four-star officer who would also be responsible for various Tri-Service Operational Commands. The Service Chiefs will continue to exercise operational control and staff functions over their respective Services. The proposed set up will allow HQ IDS under Permanent Chairman of the Chiefs of Staff Committee to function as an effective advisory system to the Govt on matters of policy, joint acquisitions, joint capability building and training.

VAYU : With the first three women recently commissioned into the IAF as fighter pilots, has this paradigm step been taken in deference to the government's policy to empower women, or is this the start of an expansion in fighter pilots' strength for the future? May we have your views on the subject!

CAS: The IAF has always been at the forefront in empowerment of women. It was the first Service to induct women as officers amongst the three Services. IAF follows a gender-neutral policy and provides equal opportunities to all its personnel.

With availability of over 20 years of data in terms of performance of women officers and their amalgamation into Service, it was felt that the large talent pool may be tapped and entry of women as fighter pilots may be allowed on an experimental basis. This would allow the IAF to examine its future combat employment philosophies as well as policies for employability of women in the flying branch, based on results of the said experiment. Such a step would also provide motivated young women of the country with an opportunity to fly fighter aircraft and undertake the designated roles.

The decision to induct women into the fighter stream was also a consequence of Government's directions for laying down a comprehensive road-map for opening up of additional branches in the three Services for grant of Permanent Commission to women officers.

Newly commissioned women fighter pilots, Flying Officers Avani Chaturvedi, Bhawana Kanth and Mohana Singh, with Defence Minister Manohar Parrikar at Dundigal in June 2016 (photo: IAF)

VAYU : On the eve of Air Force Day 2016, kindly convey a message to the air-warriors under your command, and also to the young men and women of the country who will make the IAF their careers in the near future.

CAS: As the Indian Air Force completes 84 years of illustrious service to the Nation, the proud men and women in blue deeply cherish the IAF's glorious past while they prepare to embrace an exciting and yet challenging future. It is a momentous day as we celebrate our achievements while paying rich tributes to our veterans who have laid the strong foundation of our formidable force.

In the year gone by, the IAF has continued to grow from strength to strength and it achieved a number of operational milestones. The IAF's participation in international exercises demonstrated our growing strategic reach and power projection capabilities. The IAF's swift and prompt response during various contingencies in aid of civil authorities both within India and abroad was indicative of the IAF's HADR capabilities.

The Indian Air Force today stands at the threshold of acquiring multi-spectrum strategic capabilities, synonymous with India's growing regional stature and expanding national interests and is progressively nearing its goal of transforming into a true network centric aerospace force. The IAF is also focussing on indigenous acquisition of aircraft, radars, missiles and other aviation equipment in consonance with the 'Make in India' initiative. The induction of the indigenous Light Combat Aircraft Tejas into the IAF is a testimony to the IAF's commitment for furthering indigenous capabilities.

Another first was the commissioning of three women officers as fighter pilots in the Indian Air Force. The IAF offers a very challenging and exciting career for the young men and women of our country. The opportunity offered in the IAF to work with aircraft and systems operating cutting edge technologies is unparalleled.

On the eve of the 84th anniversary of the IAF, I would like to convey my best wishes to all air-warriors and assure all my countrymen full-hearted support from the IAF, in our collective march to take the Nation forward.

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The Rafale Merry-Go-Round

15 years after the MMRCA programme was initiated, five years after the Dassault Rafale was selected, and now that it has finally been ordered, Air Marshal Dhiraj Kukreja reviews the saga and its impact on future capabilities of the IAF.

The Air Force Day celebrations are around the corner, and naturally the operational capability of the IAF will once again be in focus and scrutinised in public. The Chief of Air Staff will have to answer questions, asked by many, repeatedly asked over the last 12 months and even earlier. He will have to display cautious optimism, without even a faint hint of worry in his voice, lest he be misinterpreted. The delayed acquisition of the Medium Multi Role Combat Aircraft (MMRCA), and now its limited purchase, will be an obvious topic.

The acquisition of 126 MMRCA aka the French Rafale, selected by the Indian Air Force was termed as the 'mother of all defence deals', keeping in mind its initial budget allocation of about Rs 42,000 Cr ($ 10.25 billion) has increased incrementally later, to over $20 billion because of some 50 odd "un-priced" items. Today, however, the cost, in dollar terms would be far higher, from that originally budgeted. A depreciating Rupee with respect to the Dollar since the RFP was issued, will force us to effectively pay about three times as much, or nearly Rs 120,000 crore, just in initial acquisition costs! Such an amount would create a substantial dent in the Defence Budget while making a significant contribution to the French coffers, especially in these difficult economic times !

However, today that 'mother of all deals' is buried, so why worry over the overwhelming figures ? Nevertheless, despondency of the IAF had turned to some cheer last year, thanks to the Prime Minister, as the negotiations imbroglio that had been carrying on for three years was partially resolved in April 2015, by opting for the direct purchase of 36 aircraft. So far, however, even this scaled down number of 36 seems to be a distant dream, with negotiations carrying on endlessly.

Why the Acquisition ?

Aircraft manufacturers of the world and interested observers are completely aware that the IAF desperately needs fighter aircraft to maintain some semblance of a balance of force with its adversaries. The numbers in the combat fleet have been steadily declining from the authorised figure of 39.5 squadrons and today the IAF has 'lost' almost a quarter of its strength to obsolescence, apart from normal attrition.

Proponents of an effect-based force, on the other hand, have "no worries" as the recent acquisitions of Su-30s have multiplied the capability of delivering ordnance. While such capability increase is indeed welcome, an augmentation in numbers is equally required. Then again, evolving changes in the geo-political scenario necessitates a relook of doctrinal perceptions. The IAF, at turn of the century, finally shed its long-standing image of remaining a tactical force, maintained essentially to support the Army and Navy. The then CAS, Air Chief Marshal FH Major, on eve of the Platinum Jubilee of the Air Force in 2007, had stated, "Given the Indian situation,

our concerns and aspirations, a strong and comprehensive aerospace capability is an inescapable necessity." The 'strong and comprehensive capability' that the erstwhile CAS spoke of, comprises long-reach, all-weather, precision, networked and space-enabled resources – but also in sufficient numbers.

The Selection Process

What is so great about the aircraft type that the IAF selected over five similar aircraft that had responded to the Request Proposals (FRP) in 2007 ? Going back into contemporary aviation history, when the Dassault Rafale programme was initially launched, this was to meet the joint requirement of the French Air Force and French Navy for a multi-role aircraft that could possibly replace the seven types of combat aircraft then in service. The new aircraft, as envisaged by the French Air Force and the Navy, would be able to carry out a very wide range of missions: from that of routine air-defence, air-superiority, area denial, reconnaissance, close air support, to dynamic targeting, anti-ship attack, and nuclear deterrence missions. In addition, 'buddy-buddy' refuelling capabilities were also demanded. Designers of the aircraft very well addressed all the requirements put forth by the users. In the Rafale's design & development, Dassault had designed a superb aircraft not only met but surpassed the required mission.

The Indian Air Force, although having issued its RFI for 126 MMRCA in 2004, only got down to seriously pursuing this some years later. After delays lasting almost two years beyond the planned December 2005 issue date, the Ministry of Defence (MoD) finally released the formal Request for Proposal (RFP) in August 2007. The blame for delays, however, cannot be placed solely on the Ministry's door. The changing geo-political situation dictated requirements to boost strike capability with an extended

range to meet out-of-area contingencies and many other factors contributed to the delay, in equal measure. These included a new offset policy introduced in 2005, later updated even before its full application; the maze of the Defence Procurement Procedure (DPP) and, not in the least, hectic behind-the-scene political lobbying by the various nations in competition.

Defence acquisitions, more so Air Force acquisitions, normally have a long gestation period. While planning the procurement of an aircraft, not only is the threat perception and appropriate utilisation to be considered, the life cycle costs of the aircraft are equally important. Probably for the first time, the IAF, before placing an order, factored in the life cycle calculations, taking service life to be around 40 years, with maintenance requirements to be met for the entire service life, be this through transfer of technology, through offsets, or otherwise. The planning exercise for such calculations takes time, not only for the buyer, but also for the seller. The OEMs were asked to submit their proposals in response to the RFP, a 211-page document, in the stipulated six months.

Four years, and much evaluation and trials later, at the biennial Aero India Show at Yelahanka, in February 2011, the various fighter aircraft manufacturers of the world remained on tenterhooks, even as they displayed their aircraft, awaiting results of the evaluation process that were to be announced in June. Come June 2011, the MoD, after having studied the massive volumes of files containing data, compiled by the IAF, finally shortlisted the Dassault Rafale and the Eurofighter Typhoon to meet with IAF's MMRCA requirement. The decision was immediately termed by some as "operationally flawed, politically influenced". This result however was based on the meticulous evaluation process and the flying trials conducted by Indian Air

Force test pilots; other elements of the proposal, namely, transfer of technology, chosen offsets, and the costs were however not considered at this stage. As would be expected for a commercial deal of such magnitude, the aftershocks started almost immediately. Neither of the American F-16 nor F-18 aircraft, two types from the USA, were included in the short list and one could well wonder if the resignation of the US Ambassador to India the very next day after announcement was mere coincidence, or an angry recall from Capitol Hill in Washington DC !

The next step as laid out in the DPP was formal opening of the commercial bids of the two companies. The IAF had, from the very initiation of the deal, decided to patiently follow through the DPP so as not be caught on the wrong foot later during scrutiny of the contract. Negotiations with the two manufacturers, which commenced soon thereafter, included detailed and lengthy parleys on offsets, transfer of technology, apart from reduction in cost of aircraft and spares maintenance support.

Then, on 31 January 2012, the MoD announced that the Dassault Rafale had been selected for further exclusive negotiations. The Rafale had been chosen for reasons that included "lower per-unit-cost and lower overall life-cycle cost, with lower fuel consumption and simpler maintenance requirements", as compared to its competitor, the Eurofighter Typhoon. It was expected that the process of finalising the contract would now pick up pace, but the negotiations continued to move at a snail's pace over the next three years! As mentioned earlier, credit goes to the IAF, which, knowing that the procedural delays can wear one's patience thin, had meticulously followed each step, lest it face allegations of manipulations; the delays, however, came in a different garb.

The Delays

There was hectic activity to progress the case for the Raksha Mantri's approval and financial nod from the Finance Ministry, before the final approval of the Cabinet Committee on Security (CCS). While there was harried movement between the various departments of the government, a Member of Parliament (MP) from a regional party of South India, questioned the procedure followed. On 27 February 2012, in a letter to the then RM, he alleged errors in the appraisal and costing processes followed by the IAF and the MoD, to select the lowest bidder. The complainant, as quoted on the site www.indiatoday.in on 13 March 2012, wrote, "The alleged manipulation of the evaluation process in picking the L-1 contractor, which resulted in a decision to procure 126 MMRCA, has raised serious apprehensions not only across the country but also worldwide. If a proper decision is not taken, the country's credibility will be at stake." One does not doubt the intentions and the integrity of the complainant. Nevertheless, one would have definitely liked to know the sources of his allegations, his personal knowledge of the evaluation and costing process, the DPP, and his awareness of the impact that his complaint could have on national security preparedness, should the deal fall through – as in fact it did happen !

After such a formal protest, as could be expected, the government constituted an independent committee of three observers, all appointed by the Central Vigilance Commission (CVC), and which included former high-ranking Finance Ministry and Defence Ministry bureaucrats. The Committee reported to the MoD, much to the relief of the IAF, that there had been no deviation from the procedure, as stipulated in the DPP. The IAF, at least now, expected the process of finalising the contract to be hastened, to make up for the delay caused, but the negotiations inexplicably continued to move at a snail's pace over the next two years, 2012 to 2014.

Circa 2014

The Nation now saw a change of Government in May 2014. The "now-on now-off" progress towards finalising the Rafale deal, however, continued, and has had a telling effect on the operational capacity of the IAF. It was in April 2015, with the decision to purchase 36 Rafales in 'fly away condition', that Prime Minister Narendra Modi's grand effort bailed out the Dassault Rafale deal from the bureaucratic quagmire.

Notwithstanding the PM's personal decision, the negotiations have once again been dogged by escalating costs, leading to gridlock over pricing and offset obligations for the deal may had been broken. The DAC's approval, it was hoped, would mean that the government-to-government agreement between India and France could be signed soon, but how soon was the question ?

Alternatives

Which brings us to the (multi-billion) dollar question ! Does the IAF have any options beyond the Rafale? What would be repercussions of the Rafale deal falling through? With continuous phasing-out of the vintage MiG series owing to developed aircraft is not in the same class as the Rafale, but is certainly more capable than the MiG-21. Sceptic armchair air power commentators would like to compare the LCA's performance with that of the Rafale, in terms of cost and suggest that larger numbers to be procured by the IAF, not bothering that the two aircraft types are a class apart, just as apples and oranges are !

The only redeeming feature for the IAF has been continuous induction of more Su-30s. Their deployment is now spread across the country, from the far eastern to the north western sectors; in combination with force-multipliers, the IAF is quite

further delays. A team from India, led by Deputy Chief of Air Staff had submitted a list of technical alterations, which, the French seemingly accepted, but with consequential increase in prices, and delay in supply of the aircraft. Then, it is learnt that the MoD has been insisting that Dassault invest 50% of the overall contract price as "offsets" in domestic defence or internal security sectors, a demand as per the DPP and Offset Policy (what vintage, one really does not know !). While the French are amiable to the 50 per cent offsets, this too would considerably increase the total cost. Political intervention, once again, became necessary and according to some sources, it was up to the National Security Advisor (NSA), Ajit Doval, to salvage the deal with a quick visit to France. The Defence Acquisition Council (DAC), the apex body of the DPP, cleared further discussions on 1 September 2015, indicating that the obsolescence, the combat fleet of the IAF is decreasing in numbers, thus affecting the operational potential. As against the authorised strength of 39.5 squadrons, the IAF is already down to 30 squadrons (or even lower), which includes some weary aircraft types such as the MiG-21M! Present calculation of the lifespan of the MiG-21Bison series, indicates that these aircraft are due to be retired from service by 2019; a year or two can at best stretch that date. With progressive phasing out of these aircraft, the IAF's squadron strength would further plummet if new inductions do not take place.

Notwithstanding the much-celebrated induction of two LCAs, the originally planned a replacement for the MiG-21, its operationalisation is still some way away. The LCA's Final Operational Clearance (FOC), planned for end of 2015 is yet to happen. This largely Indian-designed and capable of handling a two-front conflict with this fleet, which has provided the IAF with strategic reach and muscle-power to counter threats, both within the country's airspace, over the high seas, and in out-of-area contingencies. The aircraft, though not initially designed to carry strategic weapons, will soon carry, after necessary modifications, the Indo-Russian BrahMos supersonic missile. It is also reported that the aircraft will be suitably modified to carry the nuclear-capable Nirbhay missile as well. If delivering the 36 Rafale aircraft are delayed once again, perhaps the only option available for the IAF is to increase the numbers of its Su-30MKI fleet, while planning to acquire an upgraded fifth-generation version, and maintaining the upgrade programmes of the other combat aircraft in its fleet.

Upgrade of the MiG-29 fleet commenced in 2007 and is likely to be

completed this year. The MiG-29UPG will have increased fuel capacity, new airborne radar in combination with other avionics, and new weapons.

Modernisation of 50 Mirage 2000 aircraft of the IAF was contracted for in 2011 with the task to be completed by mid-2021. Conforming to standards of the Mirage 2000-5 Mk.2, these include a new radar, weapons suite, missiles, electronic warfare (EW) systems and much else. During this process, the Mirage 2000 will undergo deep overhaul, extending its service life to the early 2030s. Alongside, a separate contract for the supply of 450 MICA missiles for the upgraded Mirage 2000 will add potency to the already formidable fighter.

The Jaguar strike fighter, manufactured under licence by HAL, has been in service with the IAF since 1979, and has a proven record of reliability, operated by six squadrons of the IAF. The aircraft is also being upgraded (Darin III), which is likely to be completed by 2017. The aircraft will then have a multi-mode radar, glass cockpit, an upgraded navigation and attack avionics system, Hands-on-Throttle-and-Stick (HOTAS) controls, an Integrated Defensive Aids Suite (IDAS), and possibly increased power, in shape of new engines from Honeywell.

Sobering reality

However, there is sobering reality with questions on the Rafale 'deal' continuing to haunt us.

Some of these are:

- ★ What are the terms and conditions for the supply of these 36 aircraft?
- ★ What will be the infrastructural, maintenance and sustenance requirements, and who will be responsible for providing the facilities?
- ★ How soon will Dassault begin to supply the aircraft? Will India have priority, or will it be in the queue behind Qatar and Egypt, who have already signed deals and without offsets?
- ★ Is this a 'stand-alone' deal or will there be a follow on programme as per the original requirement for 126 aircraft, with similar terms and conditions?

Doubting Thomases of all castes and creeds will have many more questions and comments to make. They are questioning the high cost of the Rafale vis-a-vis the Typhoon or the Gripen, or even the indigenous LCA! Statements like "affordable air power is effective air power", are doing the rounds in New Delhi.

Notwithstanding all this, it is the Indian Air Force which has to fight future battles in the air and if its experts, after due process, had recommended the Rafale as the "best", their judgment needs to be respected.

The author retired as the AOC-in-C of Training Command, IAF on 29 February 2012. A pilot by profession, he has flown various fighter and transport aircraft (MiG-21, MiG-23, An-32, Il -76, Do-228). He is the first Air Force officer to have undergone an International Fellowship at the National Defence University, Washington DC, USA while simultaneously pursuing a post graduate course in 'National Security Strategy' from National War College, USA.

Note: The Rafale has been contracted for by the Indian MoD since this article was written – Ed.

The Indian Air Force

Challenges and Opportunities

Mirage 2000s (pictured), Jaguars and MiG-29s will remain in service well into the next decade (photo: Angad Singh)

The Indian Air Force is once again at a crossroads (*Déjà vu ? see Vayu Issue November 1974*). In an age of increasingly costly weaponry and an almost static defence budget, the IAF faces the numbers crunch and feels it is underequipped to defend India's geographical borders. If this pressure weren't enough, additional stress comes from a strong power projection lobby in favour of the Indian Navy and enhancement of its long-range blue water capabilities. In the midst of these contradictory impulses, the IAF clings to an adamant position that it cannot function with reduced numbers, and runs the risk of appearing fiscally reckless. At the same time it has also failed in convincing the country's leadership, either by argument or by demonstration, of the pressing need to move towards a versatile 'air-centric' approach.

This article examines the main obstacles hindering India's movement towards an air-centric paradigm. It will navigate the various issues of army-centrism, opposing forces, fleet size and finances. More than any numbers game, there are the critical issues that will shape the IAF over the next decade.

Continuing Army-Centrism

Almost every major power has in the last few decades moved towards comprehensive air-centrism. This started becoming apparent during the 1991 Iraq War and since 1991 campaigns such as those in the Balkans, Iraq, Libya indicate a consolidation of the trend. Russia too seems to have now moved towards this direction albeit more grudgingly. As opposed to the massive Operation Storm 333 that involved assassination then Afghan President Hafizullah Amin, the elimination of Chechen leader Dzhokhar Dudayev was a relatively surgical affair carried out

by precision bombing. Similarly the main thrust of Russia's ongoing campaign in Syria seems overwhelmingly air-centric and at the time of writing seems to have turned the tide against ISIS and other terrorist organisations. Whether China moves towards air-centrism remains to be seen, even as President Xi Jinping has set in motion reduction in the People's Liberation Army and augmenting of Air and Naval forces.

India remains the only world power not following this trend. The planned mountain strike corps is under formation adding between 30 and 60 troops to an already large army around 1.2 million with a further 960,000 reserve. Contrast this with the US Army, which had by 1975 – despite its many international commitments and formidable foes – reduced its size to 780,000 and today this number is around 500,000. At the same time, there seems to be almost no visibility of air power in recent Indian retaliatory attacks or planning. The June 2015 attack on hostile NSCN-K militants sheltering in Myanmar, despite its suitability for air power, was carried out as a cross border infantry raid, albeit in helicopters. The raid seemed to suggest that air power was not chosen owing to its "escalatory effects." Similarly plans to eliminate the noted terrorist Dawood Ibrahim in Karachi also seem to have been planned as a long, painful, extremely high risk, low deniability, commando operation inserting troops on the ground in Pakistan. In *Operation Neptune Spear* that eliminated Osama Bin Laden in May 2011 the need was to visually identity of the resident, which necessitated such an airborne assault. In the few cases where air attacks have been contemplated, such as striking terror targets in Pakistan Occupied Kashmir, satellite imagery shows

Mi-35 in action during the Iron Fist fire power demonstration in 2013 (photo: Angad Singh)

Indian decision-makers continue to eschew airborne strike options (photo: Angad Singh)

Trio of Su-30MKIs release ordnance during an Iron Fist exercise (photo: Angad Singh)

that the nature of these facilities as dispersed and sub-optimal for such targeted attacks.

This brings about two unique features of Indian thinking on the employment of air power : first that air power is considered synonymous with high collateral damage and second that the mere physical presence of air power is considered a "disproportionate response." The flexibility and scalability of the final effect is not calculated for proportionality but rather the method of delivery. Consequently western protestations about "the flexibility and precision" of air power mean little in a country that does not consider effects based operations. On the other hand, in the West and surprisingly even among India's neighbours – Pakistan and Sri Lanka for example – ground forces are considered far more threatening than air and naval forces.

This is possibly the great challenge of the next decade : the mindset of the political and executive leadership of India. How does one get an omnipotent civilian executive (both elected and unelected) that is actually casual about defence matters to change their army-centrism and convince them that air power can do everything with greater precision and flexibility than the land forces ?

In fact, air-centrism also addresses another major concern that has driven the deliberate dysfunctionality inflicted on the Indian military – that of 'coup-proofing' India. As Steven Wilkinson has pointed out in his book *Army and Nation – The Military and Indian Democracy Since Independence*, the fact that coups did not happen in India was not mere happenstance, but rather the result of systematic efforts put in place by our founding fathers as far back as the late 1920s. Anticipating Independence, the structure and functionality of the military were carefully studied and a series of decisions taken to break up the coherence of the Army. Post independence many of these trends continued – very deliberately. Srinath Raghavan, in his book *War and Peace in Modern India*, points out there was reluctance of India's first Prime Minister to securitise issues even in situations that were visibly already securitised. In effect

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The Indian Navy is cognizant of the advantages of air power, and is rapidly modernising and expanding its air arm (photo: Angad Singh)

one could reach the conclusion that the formative years of India saw the striking of a careful balance: keep the Army functional enough to ward off external threats but not internally coherent enough or structurally powerful enough to inject itself into politics or oust governments. Managing this dilemma has meant that India's restrained military has never been able to optimally protect national interests, leave alone projecting power abroad.

Thus, air- and naval-centrism would bring a completely different dynamic to India's need to assert civilian supremacy in that it facilitates a significant reduction in size of the Army and any possibility to "influence the political system". An army whose focus is on defending territory – leaving the offense to air and naval forces – is fundamentally a compact army, designed not to occupy hostile territory but merely to defend and control friendly sovereign territory. Such an army is also incapable of carrying out a coup or exercising disproportionate influence on government. Increasing India's military capabilities by several orders of magnitude while reducing the overall size of the forces, to quite possibly half of their current size with careful planning, seems to be the way forward.

Such a shift to aero-naval-centrism would also mean structural coup-proofing. The closest (albeit imperfect) comparison one can draw is the course of the British and French militaries through the 18th and 19th centuries. Britain, which prized its Navy above all other Services, ensured political stability at home. India for example was controlled by no more than 100,000 British troops, the bulk of the Army being recruited locally. This maintained a balance (though probably not intentionally) between having a large force abroad, but not big enough at home to be politically decisive. France on the other hand – being a continental power- maintained a large ethnically French army on its home soil and paid the price for this as can be seen in the coups of Napoleon and others through much of the 19th century and well after.

The Numbers Game

The IAF continues with a heterogeneous fleet of combat aircraft and support assets of varying origin and ages. The IAF's combat

After over half a century of service with the IAF, there still are nine squadrons of the venerable MiG-21 on the order-of-battle today (photo: Simon Watson)


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Projections : IAF fighter Squadrons 2016-25			
Year	**2016**	**2020**	**2025**
Type			
MiG-21	9	6	0
MiG-27	3	0	0
Jaguar	6	6	6
Mirage 2000	3	3	3
MiG-29UPG	3	3	3
Su-30MKI	11	14	14
LCA	0	2	4
MMRCA	0	1	2
FGFA	0	0	3
AMCA	0	0	2
TOTAL	35	35	37

inventory is beset by poor reliability, exacerbating the quantity problem versus India's neighbours, or by poor combat efficacy, with aircraft systems and munitions often failing to produce desired results. The support fleet, particularly transport aircraft and utility helicopters, fares somewhat better. The IAF is the premier Humanitarian Assistance and Disaster Relief (HADR) force in the region, and its transport assets have been highly visible – and have proven invaluable – time and again over the past decade or so, in operations ranging from flood relief to earthquake response. Laudable though these undertakings are, they are not the IAF's core responsibility, which is another reflection of the Indian mindset regarding air power. Indeed, most of the IAF's support assets – tankers, AEW&C, C3/ISR platforms – remain woefully deficient, both in number and in capability.

It is obvious that even in the best circumstances, the IAF will only be close to a 40-squadron force a decade from now, and even then with two major caveats – first, nearly half the force will by then be either obsolete or obsolescent, and second, the entire projection hinges on a number of programmes that are at various stages of development today, and will need to go off smoothly over the next few years.

By comparison, the Pakistan Air Force today operates 20-odd fighter squadrons, but with a running production line for the JF-17 Thunder, as well as access to the latest in Chinese developments. With or without further access to F-16s, the PAF is already recapitalising its force, and although ambitions to expand may be limited by fiscal realities, the PAF is a frequent beneficiary of both American and Chinese largesse, so cannot be disregarded as a serious adversary.

The PLA Air Force (PLAAF) on the other hand already massively outnumbers the IAF, with over 80 operational combat squadrons, including a number of bomber squadrons (essentially standoff strike cruise missile carriers) – the only Air Arm in the world that has maintained this capability alongside the Russians and Americans. In addition to a range of indigenous fourth-generation types under production, the fifth-generation Chengdu J-20 fighter has entered low-rate production, and is expected to be in frontline service before 2020. A second fifth-generation fighter, the J-31 is also under development, and will probably become operational a few years after its larger sibling.

Clearly facing combined hostile forces of nearly 100 squadrons, the Indian Air Force cannot rely on quantity but has to shift decisively to quality solutions. However, the current plan seems to require both quality and quantity – disregarding the fact that quality comes at a very heavy price. The Indian Air Force, as the most

Ageing MiG-27s are already obsolescent, but will continue in service over the next few years (photo: Angad Singh)

राष्ट्र के प्रहरी

WHEN A NATION FEELS SECURE IT SHOWS

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The Sino-Pak JF-17 is being actively developed to add new capabilities, and will be produced in Pakistan well into the future

The Chengdu J-20 is expected to be fully operational before the end of this decade

technology-centric wing of the armed forces, is disproportionately affected by the skyrocketing costs of weapons systems in this digital age. At the same time, India can hardly afford to downsize its air force beyond a certain point. Indeed, being forced to play 'catch up' and rapidly replace or modernise large portions of its inventory have only served to amplify these effects.

This financial tension has led to several clashes with the Finance ministry over procurement decisions. This is nowhere more apparent than the large number of programmes cleared by the Defence Acquisition Council that remain unapproved by the Cabinet Committee on Security. Long delays on a range of projects, from AEW&C aircraft, to tankers, to fighters, are examples of the funding constraints facing IAF modernisation and expansion.

While the need for maintaining current combat numbers is understandable there are several ways in which the air force can shed excess flab. The first of these would be to focus entirely on an air combat role and disengage from rotary wing (helicopter) operator. Today's fixed wing aircraft, both manned and unmanned with precision strike and sophisticated surveillance capabilities, are able to carry out much of the helicopters attack role with significantly less vulnerability. Munitions like the CBU-105 enable aircraft to decimate concentrated armour on the ground – one bomb being capable of destroying 40 tanks – from greater standoff ranges, and hence greater impunity, than an attack helicopter. As a result, the more specialised roles of helicopters such as close air support, troop movement, logistics and supply are entirely aimed at augmenting the Army while adding virtually nothing to the core mission of undisputed air dominance or power projection. Helicopters, however add financial and bureaucratic burden, involving additional procurement procedures, set up of maintenance and training infrastructure, manpower to manage them etc. Unfortunately, in an army-centric system such as India, where sheer numbers add up to a greater influence on policy issues, the IAF's helicopter force is kept to preserve this influence. One could equally argue that the extensive transport fleet comprising An-32, C-130, Il-76 and C-17 aircraft are overwhelmingly for the support of ground forces, rather than the

AWACS/AEW&C capability remains an area of concern in the IAF (photo: Angad Singh)

Lockheed Martin C-130J Super Hercules are operated in the special missions role (photo : Angad Singh)

Air Force itself, but are drawing on IAF resources.

Pilot training is critical to the air force's role of air dominance and power projection. Here too innovative new public-private-partnership (PPP) arrangements being implemented by the Royal Air Force and many European air arms hold much promise for India. The first of these is 'outsourcing' pilot training. Instead of the Air Force getting involved in a huge complex acquisition procedure, with a large capital outlay and also training maintenance crews for these fleets and maintaining a logistics train for them, the air force simply outsources the training to private companies. This means the training costs incurred come under the operational (revenue) portion of the budget, while saving capital for other priorities, with the Air force specifying the extent and specific capabilities required of the training. This has the added benefit of utilisation of idle aviation capacity in the country, the expansion of the almost non-existent pilot training infrastructure (which results in a significant expenditure of foreign exchange abroad annually) and creates a larger pool of commonly trained pilots to draw upon.

Another interesting template on similar lines is the United Kingdom's aerial tanker fleet. This involves the leasing of Airbus A330-based tankers for core missions, while the AirTanker Consortium, which owns the aircraft, is required to maintain another set of aircraft that may be operated commercially but remain available to be used by the RAF at short notice during emergency surges. The RAF is responsible for all military missions, while the AirTanker Consortium manages and maintains the aircraft, provides training facilities and provides the non-military personnel required to operate the fleet. The AirTanker Consortium earns extra revenue by using aircraft for commercial operations – mostly providing transport and tanker services to other European countries, but this capacity is diverted to the UK on a priority basis during wartime.

Obviously these are not cut-and-paste templates for the Indian Air Force, but do hold significant promise. Cumulatively, they would do much to convince the government that the IAF is a fiscally responsible force that understands operating within budgets and justifies the large capital outlay needed.

The Human Factor

Any Air Force is only as good as the men and women in the loop and this will be the major challenge of the next decade. Perhaps the single most problematic issue in the way of air-centrism in India is the Human Factor. Routine analyses of the annual defence budgets in national dailies tend to see the

Over 100 Antonov An-32s serve with several METAC squadrons and after major upgradation, are to continue for the next decade

HAL-built Dornier 228s are being operated for several roles including multi-engine conversion training, staff transportation and light logistic support (photo : Angad Singh)

salary headings as a drain on the budget rather than as an investment. In a sense this is true. If India's force-on-force approach that prioritises ground forces and requires huge armies continues, then expenditures on salaries cannot translate into genuine value additions, such as 'smart' training. Worryingly, the caps imposed on human investment impose salaries that are divorced from reality and tend to significantly disadvantage arms of the military that are heavily technology dependent, such as the Air Force.

A simple comparison in this regard would be the difference in salaries between a Bajaj auto rickshaw mechanic, a Suzuki car mechanic, an Audi car mechanic and a Boeing aircraft mechanic. The auto mechanic, because of the rudimentary nature of the machine at his disposal does not require much training. A Suzuki car mechanic would require greater training but given the limited electronic functionality and visual diagnostics his or her training would still be rudimentary and unable to command a premium rate. Audi mechanics have to deal with an extremely complex, heavily digitised car. While the car may have an entirely computer driven diagnostics systems, the level of skills the mechanics are required to have span a much broader range of knowledge and require far more in depth studies. Additionally such a mechanic would be required to have critical thinking skills in order to solve malfunctions. All of this requires an Audi mechanic to attend a number of expensive training courses every year. The investment in the mechanic, therefore, is high, and the output, skill and technical dexterity expected of him is high and consequently he is able to demand a significantly higher wage. All of this pales in comparison to an aircraft mechanic, whose skill sets are of an altogether greater complexity and the consequences of failure too high to contemplate. Salaries for airline mechanics, therefore tend to be significantly higher than those who service luxury cars.

The MoD has already proposed transferring responsibility for attack helicopters to the Army, which the IAF has strenuously opposed (photo: Angad Singh)

India suffers from several handicaps on this score. Base salaries are already

Jaguar Maritime and pilot of No.6 Squadron (photo : Simon Watson)

Recruitment and retention of personnel will be a key factor for the future (photo: Angad Singh)

The Boeing C-17 has become a symbol of the IAF's HADR outreach in the region (photo: Angad Singh)

low and an accretion of expertise is almost impossible to fund at such levels. Complicating issues is the pay structure within the military, where a tank mechanic with a far less challenging job, would get paid the same as an equivalent ranked fighter plane mechanic. This leads to either of two issues: first where adequately qualified people do not find an Air Force job worth their while or alternately those available for the job simply do not have the skill sets required for the job with funding for intensive capacity building unavailable.

This situation can be seen to apply almost across the board in the Services. It is therefore impossible to think of a true air power evolution in this country, leading to performance levels of first world air forces without matching salaries and a focus on value addition. This is an economic reality that is impossible to bypass but one that will have to be dealt with. Clearly a graded pay structure for different wings of the military will be deeply demoralising for those left out, and yet not incentivising them will severely retard any significant progress.

The Path Ahead

In the current environment and within its limited operational role as a largely constabulary and disaster relief force, the Indian Air Force appears reasonably well-equipped to meet the demands placed on it. However, if one accepts that a revolution in thinking is required to bring air power into the forefront of Indian warfighting capabilities, the path ahead is arduous. Budgets have been a concern for decades now, but there is no reason a professional force cannot adapt to fiscal realities, instead of constantly and unsuccessfully pushing back against them.

Virtually every prevailing convention will have to be upended or outright discarded, and a comprehensive review of the roles and objectives of the air force, its tactical and strategic doctrines, and its force structure (in that order) will have to take place. We have no other option.

Abhijit Iyer-Mitra and Angad Singh

Adapted from a paper on 'Indian Air Power' published in the Observer Research Foundation's Defence Primer during the inaugural 'Raisina Dialogue,' held in New Delhi on 1-3 March 2016.

Securing India's Air Power

The Master Document

The *Indian Union War Book* is the master document that lays down the duties and responsibilities of various stake holders in the security dispensation of India : the Indian Air Force (IAF) has clear responsibility for Air Defence (AD) of the country. Air and space constitute the two dimensions of aerospace. Regulation and control of all that happens in this third dimension, thus, devolves solely on the IAF. So, while other Services may have (and do have) their own air arms and their own tasking philosophies, the choreographing at the macro level of all activity in the air is responsibility of the IAF.

It is, however, surprising that despite India being a fair bit ahead than many space-faring nations, its armed forces are divorced to a large extent from possession of any space hardware or being part of the national space dialogue. While it is true that the Navy now has one dedicated satellite (GSAT 7/Rukmini) to its name, the figure is negligible compared to the numbers owned and operated by forces of other major nations. Thus, as the IAF approaches the centenary of its raising in 2032, I would debate, in four parts, what India's military hopes to achieve in the aerospace sector by 2032.

Any analysis of military capability can only be made vis-à-vis the threat that it is supposed to counter; hence, an analysis of the threat in the aerospace domain (as against the geo-political threat, which is an enormous subject by itself) would first be done followed by what Indian aerospace capability should ideally look like in 2032. This would be followed by an appreciation of what would be realistically possible in the next decade and a half vis-à-vis the ideal requirement of 2032 and round up with an articulation of what military capability targets should the armed forces, and indeed the nation, aspire for by 2047, the centenary of India's independence.

Salience of Aerospace in Warfare

The primacy of any one domain in warfare has been a point of contention between proponents of the three dimensions (land, sea and air), in which war has been traditionally prosecuted. While the entry of cyber and space has added to the debate, victory or defeat would physically manifest in the three traditional ones. The advent of air power a century ago upset a lot of equations in war fighting, a major one being one of its predominance, seen in clear terms in conflicts around the globe during the past three decades. Its impact on modern warfare came into the living rooms through television the world over in 1991, during the first Gulf War. The world saw the power of air-delivered precision weapons, the capability of airborne electronic warfare technology to influence engagements and command and control in all three domains,

the amalgamation of space based assets in the overall conduct of the campaign and introduction of stealth to bring in the element of surprise which has made air power the weapon of first choice of the politician. The development of air power would continue along the same vectors to reinforce its basic attributes of speed, lethality, precision, flexibility and responsiveness to bring a nation's power to bear at its point of choosing. These form the basis of deliberations in this article while evaluating the likely trajectory of Indian air power in the specified time frames.

Threat in the Aerospace Domain

MiG-29s on ORP (Photo : Simon Watson)

India has no territorial designs on any other country, the sole aim of the armed forces being to safeguard territorial integrity and help secure the national aim of economic upliftment of its people. If one were to articulate India's military ambition in the aerospace sector, it would be 'to possess a capability to enable the nation to use aerospace to further national interests during peacetime or in conflict situations, and prevent it being used for activities prejudicial to India's interests.' This ambition has to dovetail with the geographical span of national interest as mandated by the Ministry of Defence (MoD). The MoD's Annual Report of 2012-13 stated that *"India's size and strategic location … links its security environment with the extended neighbourhood, particularly with neighbouring countries and the regions of West, Central Asia, South East Asia, East Asia and the Indian Ocean,"* while the 2014-15 report adds that *"India's geo-strategic location makes it sensitive to developments beyond its immediate neighbourhood, in West Asia, Central Asia, in the Indian Ocean Region and the Asia Pacific region. Major geopolitical and geo-economic developments are currently transforming the global security scenario into one of uncertainty and volatility."*

In doing so, there may be points of friction with other countries that would arise, and by all trends and analyses, India needs to plan for challenges from China and Pakistan, who are generally seen as adversarial in nature. There is no gain saying the fact that in any future conflict air and space superiority would be contested with an aim to secure escalation dominance in these two domains and indeed, in the overall conflict.

China's Expansionist Tendencies

China has been exhibiting expansionist tendencies, the clearest indication coming from its 2015 National Security Paper, which minces no words in articulating that one of the strategic tasks of its Armed Forces "…is to safeguard Chinese overseas interests." This is a major doctrinal shift and an indication of China's ambition to aggressively pursue what it sees as its national interests resulting in increased apprehension among its neighbours about its long term plans. Chinese troops have often violated areas in India's northern borders and it has gone on an island and airstrip building spree in the South China Sea. A clear manifestation of its resolve in advancing its viewpoint has been its declaration of an Air Defence Identification Zone (ADIZ) in the East China Sea. The development of the DF-21A 'carrier killer' anti-ship ballistic missile as part of its Anti Access/Area Denial (A2/AD) policy has made the Americans devise their AirSea Battle concept, now in the process of being superseded by the Joint Concept for Access and Manoeuvre in the Global Commons (JAM-GC). India too has forayed into the South China Sea area as part of its 'Act East' policy for oil as well as to develop relations with countries in that region – that there

China has significant production capacity for advanced fourth-generation fighters such as the J-10

The Chengdu J-20 fifth generation fighter is already in low-rate production

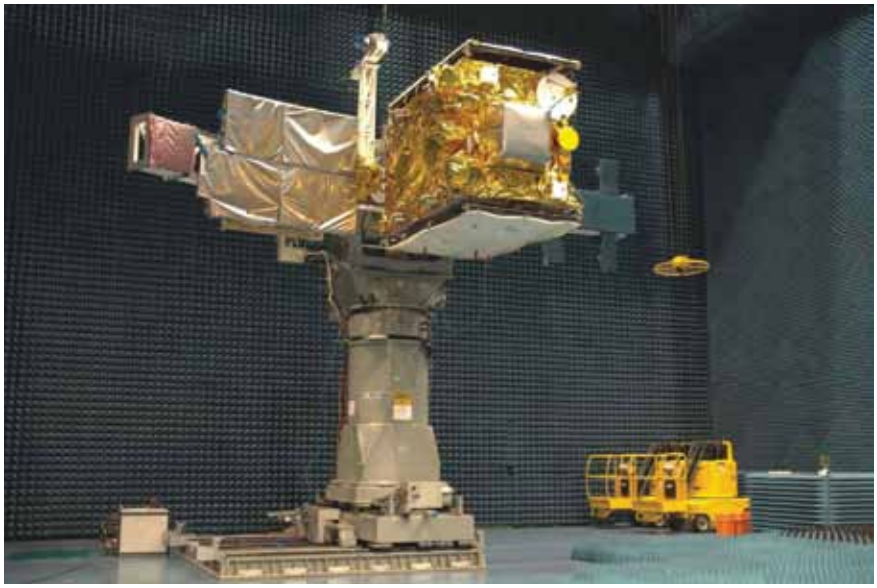
is an attempt to balance China in this outreach is plain to all observers. Closer home again, the presence of PLA troops in areas of Pakistan Occupied Kashmir under the ostensible requirement of safeguarding Chinese workers and interests in the China-Pak Economic Corridor, is a clear indicator of the application of the new declaration. One commentator has described the presence of Chinese troops as the creation of a ChOK : China Occupied Kashmir.

What would China's aerospace forces be like in 2032? At the rate at which its aviation industry is progressing, the strike arm of the People's Liberation Army Air Force (PLAAF) would include the 4.5 generation Su-35 fighter that it is now acquiring from Russia, various versions of upgraded Su-27 fighter aircraft as also its indigenous stealth J-20 (not yet a fifth generation fighter due to absence of an engine that gives it supercruise ability) in operational service. While the upgraded H-6K would be the mainstay of their bomber fleet, their Long Range Stealth Bomber project if successful, should result in these aircraft being on the verge of entering service. Force multipliers in terms of AWACS would be considerable (KJ-2000 and KJ-500) while the Flight Refueling Aircraft (FRA) fleet would be augmented with new IL-78s on order as also the FRA versions of the indigenous Y-20 heavy lift transport aircraft. The Y-20 can reportedly carry a payload of 50 tonnes; with the installation of the new indigenous WS-20 turbo-fan engine that is under flight-testing, the payload will considerably augment to 70 tonnes. With thirty-four new Il-76s on order, and many medium lift aircraft already in its inventory, the airlift capability could indeed be impressive. Also around 2032, the AWACS version of the Y-20 could be in service, adding to PLAAF's AD capability. The existing substantial heli-lift potential would improve even further with fruition of the Advanced Heavy Lift (AHL) helicopter programme that is ongoing with Russia. Thus, the combined fixed wing and heli-lift capability would translate into increased mobility and more rapid deployment across India's northern borders.

The air defence system has been greatly modernised with new reverse engineered, as well as indigenous systems. The impending acquisition of the very modern and lethal S-400 air defence system from Russia would add an over-the-horizon long distance punch; going by China's track record, a reverse engineered S-400 with more advanced Chinese electronics can be expected within a decade's time.

Meanwhile, China's naval aviation is making steady progress. Its aircraft carrier Liaoning is sailing the seas, while its second carrier (first indigenous) would be fully operational by 2032. The J-15 fighter (reverse engineered Su-33) would be the mainstay of the naval aviation strike force, and there are reports that a carrier-based version of the Shenyang J-31 stealth fighter is under development : if this be true, then this aircraft too should be operational, since the basic J-31 is already in an advanced stage of prototype testing. The naval J-31, if this programme fructifies, would truly revolutionise Chinese naval air power since all ship-based air defence systems in the region are designed to counter non-stealth aircraft; the large amount of changes required on air defence systems onboard ships of its adversaries can well be imagined. With a stated ambition of having

Chinese Navy J-15 carrier-borne multirole fighter, takes off from the 'Liaoning'



Space-based capability is set to become a key differentiator between India and its regional rivals (photo: ISRO)

four carrier battle groups in its navy, China's power projection into the Indian Ocean would then become operationally lethal.

Re-organisation of the higher defence organisation and the creation of theatre commands by China is a step towards enhancing joint military operations. The amalgamation of all missile forces and the nuclear arsenal under the newly created PLA Rocket Forces Command would introduce unity of effort in the application of the PLA doctrine, which subscribes to extensive use of surface to surface missiles against an adversary's infrastructure and surface assets (both on land and sea). Though primarily aimed towards targets in its East, the PLA may try and offset the disadvantage in the Tibetan region of low payload of its offensive aviation assets due to reduced density at high altitude airfields, by using its PLARF munitions.

Out in space, China is progressing rapidly with many innovative scientific experiments including a space station. Its Beidou (GPS) system is on its way to full operationalisation by 2020 and it has a panoply of satellites for ISR, ELINT, data relay, communications, and counter space capabilities. However, what is sinister is that it has very overtly demonstrated its Anti Satellite (ASAT) capability with 2007 successful engagements of a satellite in space; more ASAT tests have been reported although a kill has been avoided. With the WU-14 hypersonic glide vehicle well into prototype testing phase on its operationalisation, China could possess prompt global strike (strike anywhere on the globe within one hour of the decision being taken) and anti-Ballistic Missile Defence (BMD) capability, something which only the US is on its way to acquiring. However, what the Chinese armed forces lack is actual war fighting experience, a handicap that they are acutely aware of and are trying to redress by greater engagements and air exercises with Western-oriented forces like those of Pakistan, Thailand and Turkey.

When China's likely military capabilities, that would be state-of-art in 2030, are coupled with its ever increasing economic progress and engagement with countries all round the globe, the picture that emerges is one of a country that considers itself profoundly important on the world stage and a direct challenger to the United States.

Pakistan's Fortunes

Pakistan has hitched its fortunes with that of China. From the geopolitical angle, Pakistan has also been an important, and essential, cog in the attempts of the West, primarily the US, to make the Taliban and Al Qaeda ineffective (and neutralise them if possible); the entry of ISIS has only complicated the issue further. Pakistan's utility to China is vital, exemplified by the $ 46 billion China-Pakistan Economic Corridor (CPEC) project. Because of the negative asymmetry with India in terms of size of its economy, population, industrial output and conventional military strength, Pakistan can never be an existential threat to India. After having gone through a tumultuous three decades of internal

The JF-17 is the cornerstone of military cooperation between China and Pakistan (photo : PAF)

strife, some argue that Indo-Pak relations seem to be looking up slightly under the combination of the present political and military leadership, demonstrated recently between leadership of the two countries and tentative Comprehensive Security Dialogue. However, such periods of relative positivity have occurred earlier too, only to relapse into the status quo of uncertainty and hostility, demonstrated so starkly by the terror attack on Air Force Station Pathankot in January 2016; hence, it would be wise to err on the side of caution and view Pakistan as a security challenge for the next two decades, at least, and evaluate its aerospace threat accordingly.

That Pakistan has well equipped and capable conventional armed forces is a given. Its use of sub-conventional and irregular warfare against India as a matter of state policy through use of so-called non-state actors has been well documented and accepted by the world. Its coherent strategy of projecting itself as being an unstable nuclear weapons player brings an element of international inquisitiveness whenever there is an increase in Indo-Pak tensions. As was reported, "Pakistan has a strategy of pointing a gun to its own head and threatening the US that it would shoot itself unless US aid continues" – implying that if Pakistan becomes unstable, then nuclear weapons may fall into the hands of terrorist entities! State-sponsored cross border terrorism, however, continues and Pakistan links it to the Jammu and Kashmir (J&K) issue, which is vexed, intractable and unlikely to be resolved soon. Hence, Pakistan's aerospace capabilities need to be factored-in by India's security planners.

The Pakistan Air Force (PAF) is a capable arm with a modern and automated air defence system. Its assets are a mix of upgraded legacy Mirage III fighters, Chinese origin J-7s and the very capable F-16s, eight more of which ordered but "withheld" by the United States. (16 ex-Jordanian early model F-16s are reportedly being considered for acquisition by the PAF). There are also reports that Pakistan has given a veiled threat that if this doesn't happen the PAF would go in for Russian fighters (Su-35 procurement has been hinted at).

The JF-17, multi-role light fighter aircraft born out of China-Pak collaboration, is a recent entrant in the PAF inventory. It is being upgraded with air-to-air refueling capability, Beyond Visual Range (BVR) missiles and a modern Active Electronically Scanned Array (AESA) radar; it is interesting to note that though the prototypes of aircraft and upgrades are developed and tested in Chengdu, the series production is taking place in Kamra with Pakistan aggressively marketing the aircraft abroad. The point is that Pakistani's aviation industry is

Pakistan presently operates a fighter fleet of mixed origins and vintage, from the Chinese F-7 (above) to the American F-16 (below)

slowly but surely making progress. By 2025, as India aims to get stealth aircraft like the Russian Fifth Generation Fighter Aircraft and/or the indigenous Advanced Medium Combat Aircraft (AMCA) by 2030, Pakistan is likely to pitch-in for the Chinese stealth J-31 fighter that is specially made for export. PAF aircrew are experienced, follow a Western style ethos in air operations and have for years been carrying out live air to ground engagements in their strikes against rebels in AfPak border areas. In the space sector, Pakistan has a modest programme and does not have any major achievements but banks on foreign manufacturers and launch agencies for its satellite requirements. However, the fact remains that when it comes to a crunch situation, China can be expected to fulfill Pakistan's ISR needs for intelligence and targeting inputs.

The other nations in India's neighbourhood are not a security challenge but can be major irritants if they ever sided with China and or Pakistan. It needs to be noted that virtually all the military forces of India's neighbours have been equipped with Chinese weaponry and aircraft, which implies that China's influence on them cannot be neglected : this is a challenge for Indian diplomacy.

Indian Armed Forces in 2032

Import of the cliché that 'capabilities take time to build but intentions can change overnight' can be neglected at one's own peril and hence an evaluation of what Indian aerospace power should look like in 2032 must factor-in an assessment of the threats emanating from the modernisation trajectories of armed forces of its adversaries.

The deterrent value of India's military's strength should be inviolate so that no country interrupts India's drive for economic upliftment of its masses. If deterrence breakdown occurs, there is no doubt that India's response to any mis-adventure or an anticipated one (pre-emption is hinted here) would be led from the air. The disadvantage of difficult terrain that prevails on the frontiers, especially the Northern border, would be overcome by taking the fight deep into the adversary's territory, so as to make it difficult for him to fight a land battle on the borders.

To manage a two-front collusive challenge mounted by China and Pakistan, the IAF should have its full complement of 42 fighter squadrons, first arresting the depletion of fighter strength (owing to phasing out of the MiG-21 and MiG-27 fleets) and then rapidly building up their numbers. This assumes that the 36 Rafale multi-role fighter aircraft should already have been inducted and there should be no hiccups in the schedule of Su-30sMKI deliveries to their contracted number of 272 by 2019. But the major difference in arresting the slide in squadron strength and making up of numbers would be made by the induction of the Tejas Light Combat Aircraft and a "new fighter type" which India's Defence Minister alluded to in February 2016. These should ideally be complemented by the IAF's stated requirement for 15 AWACS and 19 Flight Refueling Aircraft (FRA).

The airlift component is already in place with the acquisition of all C-17s and C-130s and the upgradation of An-32s and Il-76 aircraft; the induction of Airbus C-295s, for replacing the old Avro aircraft, should complete the picture.

The heli-lift component should be in place with operationalisation of the 15 Chinook helicopters contracted-for and the availability of the three remaining heavy lift Mi-26 after their life extension – in fact the Mi-26 fleet would be at the fag end of its life with the IAF. The Mi-25 attack helicopters would be phased out soon and the 22 Boeing Apaches operationalised.

The IAF's Air Defence system, comprising obsolescent Pechora and OSA-AK Surface-to-Air-Missile (SAM) systems, should have been revamped with the indigenous Akash SAMs and quick reaction Spyder system from Israel. The Medium Range SAM (MRSAM) being developed with Israel should also be fully operationalised by 2032.

In 2032, India's naval air arm would be based around INS Vikramaditya and the indigenous INS Vikrant. The second indigenous carrier, INS Vishal, would be available to the Indian Navy only in the 2030s as it is still on the drawing board, with major decisions like propulsion system (conventional or nuclear), type of aircraft and aircraft launch system and so on yet to be decided. The full complement of forty

The IRNSS space segment is comprised of seven satellites, three of which are located in Geostationary Orbits above the equator while the other four reside in inclined Geosynchronous Orbits and operate in pairs, sandwiched between the GEO satellites. Each of the satellites is expected to operate for 12 years before being replaced by the next generation of IRNSS satellites

On parade: marchpast the Globemaster

five MiG-29Ks for the Vikramaditya and Vikrant would have been inducted and both carrier aviation groups fully operationalised. The naval air arm should have sufficient Maritime Reconnaissance (MR) and Anti Submarine Warfare (ASW) aircraft and helicopters to cover the vast areas of the Indian Ocean Region.

Space was famously called "the next frontier" in the 1960s. The reality is that it is now embedded in all aspects of warfare, because of the capabilities it affords in the realm of C4ISR. While militarisation of space has taken place through its use as an enabler, its weaponisation would not have happened owing to international consensus. The Indian Regional Navigation Satellite System, which would afford satellite based navigation (a la GPS) would be fully operational and dependence on the GPS and Russian GLONASS would removed. Net centric warfare, which all warfare surely will be in the coming decades, is heavily dependent on the use of space assets. An Indian Space Command should become functional to regulate and control all military space and space related issues. Turf wars must be stymied by a political fiat and the nominated lead Service should have operationalised the Command. However, it needs to be ensured that space does not become just a tool to support terrestrial warfare but is treated as an independent arena where warfare could sometime take place. More satellites, solely dedicated for military use, should have been placed in orbit for the armed forces.

Likely Indian Aerospace Capability in 2032

A year back, on eve of the IAF's 83rd Anniversary, the IAF Chief stated at a press conference that the force expects to reach its full strength of 42 combat squadrons only by 2027. This indeed would be an achievement because frequent delays in procurement from abroad and production by Hindustan Aeronautics Limited have continuously handicapped this schedule; in February 2009, Defence Minister AK Antony had said that the IAF's combat fleet would reach the figure of 42 squadrons by 2022. However, the inflow of Su-30MKIs from HAL has been slow and only 204 of the 272 contracted aircraft were delivered by March 2015. The Rafale contract remains to be signed and, on a very optimistic note, with deliveries commencing in 2019-20, the full complement of 36 may only come in by 2024 or so. The AMCA, depending on the way the design and development proceeds, would come into service only by mid-2030s to replace the legacy MiG-29s, Jaguars and Mirage 2000. Thus, some other aircraft type is required to make up the numbers; apart from the 60 odd pending Sukhois (the full lot would be in by 2019) and through the Tejas Mk1A route. The first Squadron of Tejas Mk.I, with a mere two aircraft, as against a Squadron of sixteen-plus, has been raised, the snail's pace being because of slow production rate at HAL. Even with an optimistic production rate of eight aircraft per year, HAL would be able to deliver the first twenty Mk1s only by 2018-19.

With the LCA Mk.IA still requiring development and clearance for service post resolution of IAF's major observations, commencement of their service entry would not be before 2022. Therefore, there is definite need for considerable numbers in the 2018-25 time frame to cover the phasing out of the MiG-21 variants and MiG-27 during this period. It is here that the pitch being made by the US for its F-16/18 and by Sweden for its Gripen comes into focus. Both countries have offered to shift their production plants to India under the 'Make in India' programme for producing the 100 plus aircraft required to fill the gap of the reduced Rafale purchase. The slide and build-up in IAF squadron numbers therefore would be arrested only by the mid to end-2020s with stabilising of the Tejas Mk1A production line, inflows of the remaining Su-30s, Rafales and the 'some other' multi-role combat aircraft (F-16, F-18 or Gripen).

The IAF has formed the first Tejas LCA unit (No.45 Squadron) but production rate for the type remains a concern (photo: Simon Watson)

The Sukhoi Su-30MKI 'heavy' fighter will dominate the IAF's order-of-battle for the next decade and the type will reportedly be modernised with new avionics and weapon systems (photo: Simon Watson)

The attack helicopter inventory would comprise the soon-to-be-delivered 22 Apaches complementing around twenty remaining Mi-35, as also the Advanced Light Helicopter Dhruv (WSI) versions in substantial numbers, both with the IAF and Army Aviation. The Light Combat Helicopter, whose prototype testing is underway, should start entering service with the IAF by 2022, with some 60 to be delivered by the mid-2030s.

At the same time, weapons holding of the IAF would have undergone a marked

The indigenous HAL Rudra helicopter is already entering service and will bolster the IAF's attack helicopter capability (photo: Angad Singh)

qualitative change, with substantial increase in their potency, accuracy and range. Select Sukhoi Su-30s are to be equipped with the 290-km range BrahMos supersonic air to ground missile while the Meteor mounted on the Rafale would give a BVR range in excess of 150 km. It is safe to assume that the 'new' fighter selected would also come with modern weapons and BVR capability. Similarly, the holdings of Precision Guided Munitions (PGM) should have gone up substantially.

India's Naval Air Arm would be centred on the already operational INS *Vikramaditya* and the indigenous INS *Vikrant*, which is planned to join the Navy in December 2018 but accounting for delays, 2020 would be a reasonable year to this to happen. By 2022, INS *Vikrant* should have gained operational status and, given the availability of necessary surface, air and space infrastructure, the MiG-29Ks deployed on these two carriers would enable India to enforce sea control over a vast swath of air and sea space. The capability to deliver firepower onto shore targets would also exist but would depend on availability of in-flight refueling assets of the IAF. The Naval Tejas that the Navy desires still has a question mark over it, considering the various challenges faced.

The IAF already has a very substantial airlift capability with ten C-17s, fourteen Il-76s six (plus six) C-130s, around a hundred An-32s and a new medium transport aircraft (MTA) possibly the C-295 as an "Avro replacement." As the An-32 fleet starts phasing out end-2020s, it would be

Ten Boeing C-17 Globemaster IIIs form the new 'high end' of Indian airlift capability (photo: Angad Singh)

Mock up of the BrahMos supersonic cruise missile seen attached to the Su-30MKI at Aero India 2015

logical to assume that this aircraft type too would be replaced by the MTA, as it would make operational and logistic sense to have commonality in this area. The IAF's heli-lift capability would be impressive and would be based around fifteen Chinooks and 159 Mi-17s plus the Dhruv ALH, Chetak/ Cheetah, the latter eventually replaced by the incoming Ka-226.

With induction of the lethal S-400 SAM system from Russia, 45 firing units of Akash SAMs (from Bharat Electronics Limited), Spyder quick reaction missiles and MR-SAMs, coupled with their networking with AWACS and new indigenous ground radars, the air defence environment would have undergone substantial increase in potency. Long range weapons (BVR missiles, supersonic BrahMos surface to surface

Akash surface-to-air missiles have been inducted into service

missile systems) and dynamic targeting capability with improved ISR thanks to the networking with AWACS, AEW&C aircraft and Space Based Surveillance (SBS), would give the IAF the ability to look deep – and strike far.

A caveat needs to be added here in that this network centricity would still be 'work in progress' owing the staggered induction schedule of such assets, especially space satellites. It is surmised that military personnel would have been brought into the planning and decision making loop, even as the Space Command would have been operationalised. Creation of the Space Command would also clearly convey the point that space should not be treated as an adjunct to 'air' but be a 'military medium' in its own right with its own dedicated personnel and HR policies. Thus, existence of an embryonic aerospace power should be visible by 2032 even as a "true" indigenous arms industry starts making an impact. Also visible in the Centenary year of the IAF should be a clearly defined map for the next two decades, which would encompass Centenary of the modern Indian nation.

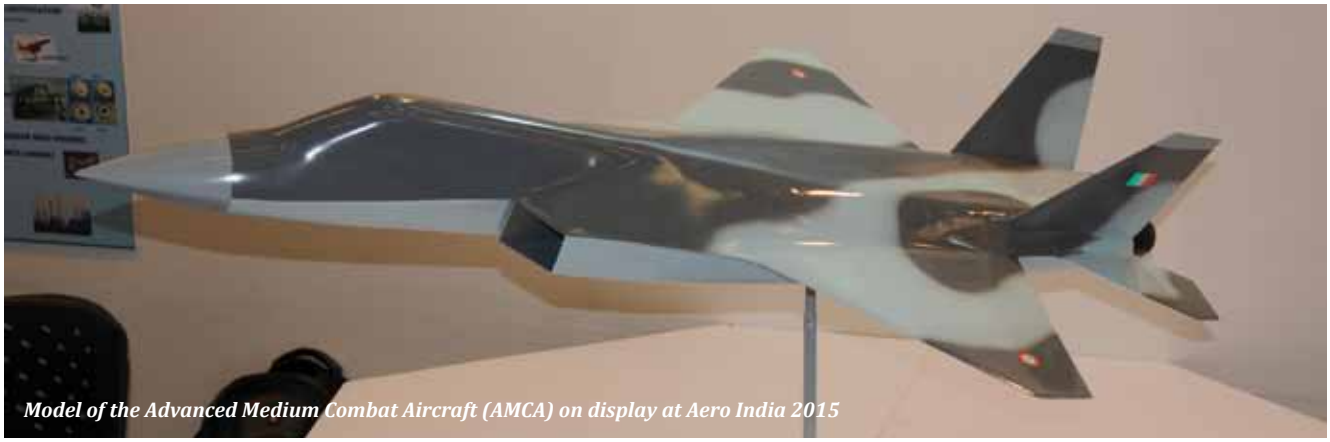
Fast Forward to 2047

So, what would the picture be like in the hundredth year of the independent Indian State? The steps being taken to set up an indigenous military industrial complex should have borne fruit by then. The Jaguar, MiG-29 and Mirage 2000 fleets would long have phased out as also the early Su-30 MKI entrants. The AMCA would be the spine of Indian air power, as also the Russian-origin FGFA (if the programme had proceeded successfully in the 2020s) plus 'the next generation' fighters alluded to earlier. The Sukhoi Su-30 would still be around, albeit in modernised and upgraded versions. Combat support elements (flight refuelers, AWACS et al) would have proliferated in numbers and capability while air defence would hopefully be one homogeneous entity.

The decade of the 2040s must see the maturing of usable artificial intelligence in 'intelligent' war-making machines; true Unmanned Combat Aerial Vehicles (UCAV) would be reality in the field of aerial combat if the development schedule of UCAVs, as given out in the USAF 'UAS Flight Plan: 2037" proceeds as per schedule. Whether India shall be somewhere there in that time frame, is difficult to forecast, but steps towards such capability would certainly have been taken.

Hypersonic vehicles (whose design phase has presumably started) would be bridging the supposed gap between air and space and would be in service, while 'space' itself would have seen a proliferation of secure Indian satellites. If the sanctity of

Surrealistic image of the T-50 fifth generation fighter aircraft



Model of the Advanced Medium Combat Aircraft (AMCA) on display at Aero India 2015

space had been breached in the interim by any country through weaponisation, India too would have taken steps to acquire such capability, through DRDO and the advanced space programmes of ISRO. Space assets would have given India the capability to support and sustain power projection capabilities offshore.

The plan for the Indian Air Force as envisaged above exists but requires money and lots of it! Where would it come from remains a moot point, with defence allocations remaining below 2% of the GDP, and likely to remain so in future?

Budgetary support for Defence Plans

The Government of India is surely doing a tight rope walk with its finances, considering the large outlay necessary for the 'civil and social' sectors, and it would be naïve to assume that all the funds in demand by defence would be made available; however, it will also be unrealistic to presume that the Government would ignore essential, and the minimum, requirements of defence. As an example, for the Rafale acquisition, the Defence Minister categorically stated, post the 2016-17 budget that, "adequate money has been kept" for the project. Similarly, the Army's artillery acquisition modernisation plan is being addressed through the M-777 howitzer for which a private sector major has been selected by BAE Systems to be their Indian production partner while for the Navy, unstinted Government backing has got the nuclear-powered INS *Arihant* on stream.

It is a known fact that such critical high value acquisitions are funded by the Government through 'special allocations' 'and similar action can be expected for pending vital acquisitions like the' some other fighter aircraft that the IAF would get through the 'Make in India' proposal. Thus, the acquisitions mentioned in this essay can be taken as substantially realistic in the given time span (from present to 2032/2047). An additional factor is that since most acquisitions would come under the 'Make in India' concept, additional jobs and revenue would be generated in-country and hence would be attractive to the national leadership. It is also assumed, from experience, that there would be greater R&D towards indigenisation since the private sector would be beneficiary of the new acquisition policies. Has such optimism been expressed earlier, but not with commensurate results to show on ground? The answer is yes, but the difference this time is the enhanced Government resolve which is visible, changing the *laissez faire* attitude of the defence industrial sector.

Proactive Power

Aerospace power, being the weapon of first choice in modern conflict, would give India the capability to safeguard its interests in a proactive way and to project power aggressively (if required) in the years leading to the nation's Centenary. The challenge is to accelerate the development of an indigenous arms industry, refresh doctrines to keep them contemporary and relevant and train leaders to use aerospace power's full potential. The assets of the IAF may have reduced in number but the potency remains adequate for deterrence and driving home an advantage, if deterrence fails. But is this sufficient for a two front conflict? The media and certain commentators have gone overboard quoting the IAF's Vice Chief's observation that "numbers are not adequate to fully execute an air campaign in a two front scenario.' What is not being discussed is the next part of his statement in which "the probability of a two-front scenario is an appreciation that one needs to do." Herein lies the crucial element of assessments made at Government level with inputs from different sources, not available to the media and the public at large.

War is a multi-disciplinary event involving the Defence forces, diplomacy and political apparatus et al. There is scarcely a country that is likely to have an infallible military dispensation and there are many ways to address the perceived gaps that may exist; these redressal mechanisms are not restricted to the military kind only. The continuous debate on China's growing military capabilities and aggressive posturing necessitates a dispassionate and professional appraisal. While this subject is vast and qualifies for an independent study, China, like any country, has vulnerabilities across the extended from Indo-China border and vast expanse of the high altitude Tibetan plateau. While its good communication infrastructure provides many advantages, a professional adversarial force will have several counter plans to nullify them, especially through the use of air power, which is an effective tool for deep interdiction.

The Indian Army and the IAF, being professional forces, would certainly have plans and appropriately equipped formations to address these challenges. The Indian Navy is modernising and the Indian Ocean is its 'backyard' with attendant advantages. China has to be concerned with protecting its sensitive Eastern seaboard too, where it has been trying to expand its influence in rather aggressive manner, raising hackles of virtually, all its neighbours. Its extensive use of ICT allows 'soft kill attack' through electronic warfare through the full electromagnetic spectrum, while any

Mi-17s constitute the bulk of the IAFs medium heli-lift force

Arguably the IAF's true multirole combat aircraft in service today is the Mirage 2000, being upgraded for frontline service till the 2030s (photo: Wg Cdr [retd] RS Chauhan)

aggressive intent demonstrated against space assets would draw an appropriate response. The 'rise' of China, although impressive, has still some way to go, as it also has to address the needs of its under-developed hinterland, which has been neglected, as opposed to the eastern seaboard areas where the benefits of its development have been concentrated. This will take up considerable resources and administrative energies as also the attention of its leadership. The Uighur problem in its Xinjiang province is not likely to be ignored and it would be recollected that in the war fought against the relatively small Vietnam, the results were rather disheartening for China, considering the positive asymmetry it had in all military and non-military sectors. Thus, while a two front confrontation for India is theoretically possible, it is not easy for any nation to go to war when its vital interests are not at stake.

Thomas Schelling has said that in the strategy of war, the event (war) is not a constant sum game as in game theory but a variable one, as "…the sum of the gains of the participants is not fixed so that more for one inexorably means less for the other." In the event, China, as any other country, would have to weigh its chances carefully before committing to war since the perception of 'victory' and 'defeat' would be different for each participant. China did not intervene in any military action during any of the Indo-Pakistan wars/confrontations that have taken place in the past half-century. If warlike tensions were to rise again between India and Pakistan, would China, a country aspiring to become a great power and a world statesman, commit itself to kinetic action on behalf of its client state or instead take political steps to diffuse the situation?

In matters military, the operations staff knows best and when one assumes the political thought process of a potential adversary, then the national civilian leadership dons the role of the executing agency : the Indian leadership, irrespective of the party in power, is sagacious and perceptive in evaluating threats to the nation's security.

There are urgent issues for sure which the Government needs to tackle, and while its numbers build up, it is incumbent on the IAF to nurse its formidable capacity for the long term and maintain its deterrent capability. This challenge is not new; it's a challenge that comes the way of the armed forces of a nation that has to address critical social obligations but surely it's a challenge that the IAF is adept at tackling head-on as it moves towards its centenary.

Air Vice Marshal Manmohan Bahadur VM (retd)

Adapted from a paper titled 'Indian Air Power: Ambitions to Secure Aerospace' published by the Centre for Air Power Studies (CAPS) in the Air Power Journal Vol. 11 No. 2, Summer 2016.

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Admiral Arun Prakash urges the MoD to "think out of the box" so as to

Save the Tejas !

(photo : Rana)

If the recent induction of the indigenous Tejas Light Combat Aircraft (LCA) has received a muted welcome from the IAF, there are very good reasons for it. While the nation and the defence-industrial complex may celebrate a milestone in military indigenisation, the service, charged with the defence of our skies, has much more to worry about.

With obsolescence eroding its aircraft strength and the Rafale deal in limbo, there seem to be no inductions from abroad on the horizon, other than some more Sukhoi Su-30s to attain the target strength of 272 'heavy' fighters. The IAF, while still seeking a 'medium' fighter, may well have to make do with the Tejas (and its future derivatives) – in terms

(photo : ADA)

of numbers as well as capability – till something else turns up.

Since much of the IAF's combat fleet is assembled, overhauled and supported in-country, this would make the service totally dependent on India's monolithic aerospace giant: Hindustan Aeronautics Ltd (HAL). This is a thought that would strike dread in the heart of any air warrior. Having flown many HAL products and been


(Photo : Rana)

associated with its aircraft and helicopter projects, I can put my fingers on (at least) four good reasons for the IAF's leadership to be apprehensive in this regard. Most of them are attributable to HAL's public-sector work-ethos, nurtured by a protective Department of Defence Production.

Firstly, the lackadaisical approach of HAL's unionised employees that engenders low productivity. Secondly, poor production-engineering standards that create maintenance and inter-changeability problems on aircraft. Thirdly, the high failure rate of HAL manufactured components and systems with attendant safety implications. Lastly, sub-optimal product-support that frequently leaves HAL customers high and dry and without any options.

Given the acceptance of Tejas by the IAF – whether voluntarily or under duress – this aircraft now assumes a key role in India's national security matrix. It must, therefore, not only be inducted in sufficient numbers in a compressed time-frame but also be accorded Final Operational Clearance at the earliest, to enable combat exploitation over its full envelope.

Concurrently, improvements, upgrades and modifications have to be wrought in the Tejas to enhance its capabilities. Given low production rates and the other attributes of HAL, as mentioned above, all this is unlikely to happen unless the Ministry of Defence (MoD) thinks out of the box, adopts an innovative approach and acts with alacrity.

Going by past precedent, it would be unrealistic to expect the MoD to undergo an overnight transformation in outlook and it would, therefore, have to be the end-users who must provide the initial impetus and sustain momentum of desired changes. At this juncture, a digression is necessary to highlight the Indian Navy's interest in the LCA and to illustrate the critical importance of customer involvement in project management.

Unbeknownst to many, the Indian Navy, in keeping with its commitment to indigenisation, has been a steadfast supporter of the LCA for decades. In its quest for a ship-borne version of the aircraft, the Navy commenced discussions with the LCA's designer, the Aeronautical Development Agency (ADA), in the early 1990s.

Initial feasibility of a naval version having been established, an engineering development programme was commissioned to seek thrust-enhancement, fitment of an arrester hook and extensive re-design of the undercarriage and fuselage for carrier operations.

Having drawn up Qualitative Requirements for the aircraft, the Navy also contributed Rs 400 crore ($60 million) to the LCA (Navy) project, becoming the only potential customer to have done so. The level of the Navy's commitment can be gauged from the fact that a naval test pilot deputed to the National Flight Test Centre rose to become its head, and the recent ADA


(Photo : ADA)

Director is a naval aeronautical engineer who was originally sent to oversee the LCA (Navy) a decade ago.

The prototype LCA (Navy) was rolled out in July 2010, and has been undergoing trials on a specially constructed carrier simulation facility at the naval air station in Goa. With three aircraft-carriers projected in its plans, the Navy would need 100-150 ship-borne fighters in the next two decades.

While the LCA (Navy) – if successful – would make up some of these numbers, the Navy (like the IAF) would also need a 'medium' fighter to equip its carriers, but one which is carrier-compatible for catapult-launch and arrester-hook recovery. Currently there happen to be three such examples in the market : the US F/A-18 Hornet and F-35C Lightning II and the French Rafale M.

Against the backdrop of the latest dispensation permitting 100 per cent FDI in defence production, coupled with Prime Minister Narendra Modi's passionate advocacy of *Make in India* and *Make for India*, the IAF and the Navy need to make common cause and capitalise on new windows of opportunity. Given the historical inability of our public sector to reform itself, the two services should urge the government to form multiple public-private joint ventures (JV) involving ADA, divisions of HAL, the Indian private sector and foreign aerospace companies.

These initiatives, which will not only transform India's aerospace industry but also bolster national security, must include joint ventures for (a) the modernisation and streamlining of HAL's existing production facilities; (b) creation of additional assembly lines to boost LCA production rate; (c) exploring, with ADA, up-gradation of the LCA and design of LCA Mark II; and (d) setting up a new aero-engine production plant for the LCA.

Should the IAF and the Navy be able to agree upon a common 'medium' fighter, they would have a powerful lever to persuade the government to set up yet another JV for its collaborative production in India.

Any move to loosen the deadly grip of the PSUs and allow private sector participation in defence will see the dinosaurs of the Left (embedded in all political parties) as well as the *status quoist* Department of Defence Production up in arms against it. This is where the Service Chiefs and the techno-savvy Defence Minister could take a common stand and pull together - in the interest of national security.

(Photo : Angad Singh)

(Photo : Simon Watson)

MBDA: "in support of the IAF"

ASRAAM on Jaguar

MBDA's long history in India is usually linked with the Milan ATGM weapon. However, this European leader in the guided weapons sector has also been supporting the IAF's operational capability and is well known by the country's Mirage and Jaguar pilots.

For many years, the IAF has looked to MBDA to provide the short range air-to-air capability for the Jaguar strike fighter and both short and medium range air-to-air capabilities for its fleet of Mirage fighter jets. These weapons, the Magic II with its infrared seeker and the longer range Super 530D with its semi-active radar seeker, have provided sterling service for around 40 years. However, operational requirements are continually changing and evolving to meet ever growing threats and challenges. Today's combat pilot is often called on to carry out multiple roles that are much more complex and demanding than ever before.

To respond to these needs, MBDA is continuing to support the IAF with a new generation of state of the art weapons as it moves to enhance the operational capabilities of its fleet of Jaguar and Mirage aircraft, while also planning for the eventual arrival of the Rafale MMRCA. These crucial projects, which place the IAF at the forefront of protecting India's sovereign air space, gives MBDA the opportunity to forge ever closer ties.

The IAF's upgraded Mirage 2000 will carry a mix of 6 IR and RF MICA missiles

The MICA has been ordered for the IAF's Mirage upgrade to replace the Magic II and the Super 530D. It is also a weapon system closely associated with the Rafale. This is the only missile in the world featuring two interoperable seekers (active

Mistral MANPADS

radar and imaging infrared) to cover the spectrum from close-in dogfight to well beyond visual range. Its ability to fly out to BVR in passive mode before the seeker locks on in the final stages of the end game has earned it the sobriquet "silent killer" as the target has little time to react or to deploy effective countermeasures

The ASRAAM has been selected for the IAF's Jaguars, which are undergoing major upgrades to extend the aircraft's life through to the end of the decade. ASRAAM's speed not only provides safe separation from the Jaguar's above-wing pylons, it also guarantees 'first shot first kill' to avoid getting involved in a dogfight. As the Jaguar is a low-flying aircraft, threats will most likely come from more agile fighters with altitude superiority, ASRAAM offers a major advantage here in its unmatched 'snap-up' capability, its ability to rapidly divert upwards once fired. It has also proved its exceptional 'over the shoulder' capability to defend against an attacker approaching from behind the wing line. MBDA recently received a contract from the UK MOD for the production of this missile for the RAF's intended fleet of F-35 stealth aircraft, a strong confirmation of how this weapon will continue to play an important role for many decades to come.

For the IAF too, operational performance is what counts. However, taking a wider viewpoint, India is set on a path towards industrial autonomy as reflected in the 'Make in India' policy of the Modi government. Both MICA and ASRAAM involve significant work carried out by Indian companies and have helped MBDA to increase its ever growing network of defence sector business partners throughout the continent.

Of course MBDA, with probably the largest portfolio of guided weapon systems of any company in the sector, is also looking forward to supporting the IAF when it is ready to bring its new Rafale into service. Though the contract has yet to be inked for the aircraft, MBDA has been carrying out in-depth discussions covering the full suite of weapons associated this 'exceptional' combat aircraft.

The MICA, already in the process of being added to the IAF's inventory, will be a key weapon for the Rafale. With Meteor having just entered service on the Gripens of the Swedish Air Force, this next generation weapon is also due to be a major factor in Rafale's future operational prowess. Meteor is a six-European nation programme that offers very long range combined with ramjet-induced speed to result in a weapon that has an unequalled 'No Escape Zone'. In fact Meteor has been designed to be many times superior to the most sophisticated current and emerging Medium Range Air to Air Missile (MRAAMs) threat. Its advantages provide an added dissuasive power to an air force in so far as any enemy will need to think seriously before venturing into potentially lethal air space as with Meteor, there can only ever be one winner! The advanced technology contained within the weapon controls speed and fuel consumption throughout the flight envelope. This ensures that maximum power and hence agility are maintained at the extremes of range where other MRAAMs have long ceased being effective.

Deep strike is a major requirement for a modern air force, particularly for a multi-role aircraft such as the Rafale. The ability to deliver a precision strike against high value targets such as well protected

control bunkers/centres, key infrastructures and military installations from a safe stand-off distance is crucial in the early days of a conflict as was shown in Iraq and Libya. The Scalp/Storm Shadow, which is in operational service on the French Air Force's Rafale aircraft (as well as with other European air forces) and which has proved its unerring and unmatched ability to combine very long range with devastating target effect during combat operations carried out by the air forces of the UK, France and Italy.

Another air-launched weapon that MBDA is discussing with the IAF is the much publicised Brimstone close combat support weapon. The capabilities of this very special, dual mode seeker equipped missile have been demonstrated around the world following its unparalleled successes in combat operations in Iraq, Libya, Afghanistan and most recently in Syria. As well as showing its ability to carry out surgical strikes under complex combat conditions where collateral damage needed to be avoided, Brimstone has been put through its paces through a series of demanding firing trials. These have been carried out from fast jets, UCAVs and attack helicopters and have included firing at targets moving at speeds of up to 70 mph from a variety of launch conditions, including long range and high off-boresight. Precision surface strikes are a major feature of the missions that a modern air force needs to be able to carry out. Brimstone, with its dual millimetric wave radar and semi-active laser (SAL) seeker, gives the pilot a great deal of flexibility. A salvo of Brimstones can be launched in fire-and-forget mode or, should man-in-the loop be required because of complex operational conditions, the SAL mode can be selected. Significantly, as Brimstone Maritime, the missile has proven its capabilities as a surface-to-surface weapon. Whether air or surface launched, Brimstone is the only weapon currently available that can engage not only fast moving land targets but also swarming FIACs (Fast Inshore Attack Craft) a fast emerging and worrying threat in coastal waters.

Another missile that plays a significant part in MBDA's partnership with the IAF is the versatile Mistral which features in both very short range surface-to-air and helicopter-launched air-to-air operations. Already integrated and tested on the HAL produced Rudra ALH Mk.IV, Mistral is also undergoing integration on the LCH. One of the LCH's intended roles will be air defence against slow moving aerial targets such as aircraft and UAVs and Mistral has proven capabilities in such operations. In its helicopter-launched version, Mistral is deployed within the ATAM system. The system is based on two launchers, each deploying two Mistral infrared seeker equipped missiles. Given the wide range of roles that the Rudra and LCH will have to undertake, ATAM will provide the helicopter's crew with a weapon that is not only easy to use but one that that can be operated in the whole flight envelope from nap of the earth to 15,000ft and at flight speeds from hovering to up to 200 knots.

The partnership around the Mistral missile has even greater significance when one considers that this same missile is being offered to India's armed forces for the VSHORAD requirement. As well as being the optimum solution in terms of portability, all-weather fire-and-forget capability, and as part of MBDA's offer, major transfer of technology is on the table. Should MBDA be awarded this very important contract, the Mistral missile would be manufactured in India. Of course, with Mistral being the missile associated with the ATAM integrated on the Rudra and LCH, operational and inventory management advantages are also obvious.

MBDA's relationship with the IAF, goes back many years, and is one that will move forward as MBDA continues to support India's fighters with the very best of modern and next generation guided missiles and missile systems.

With inputs from MBDA

Mistral ATAM test firing from the Rudra ALH

FAST BACKWARD
Circa 1962 and 2016

PLAAF MiG-17, mainstay in 1962

Unenviable situation of the IAF today

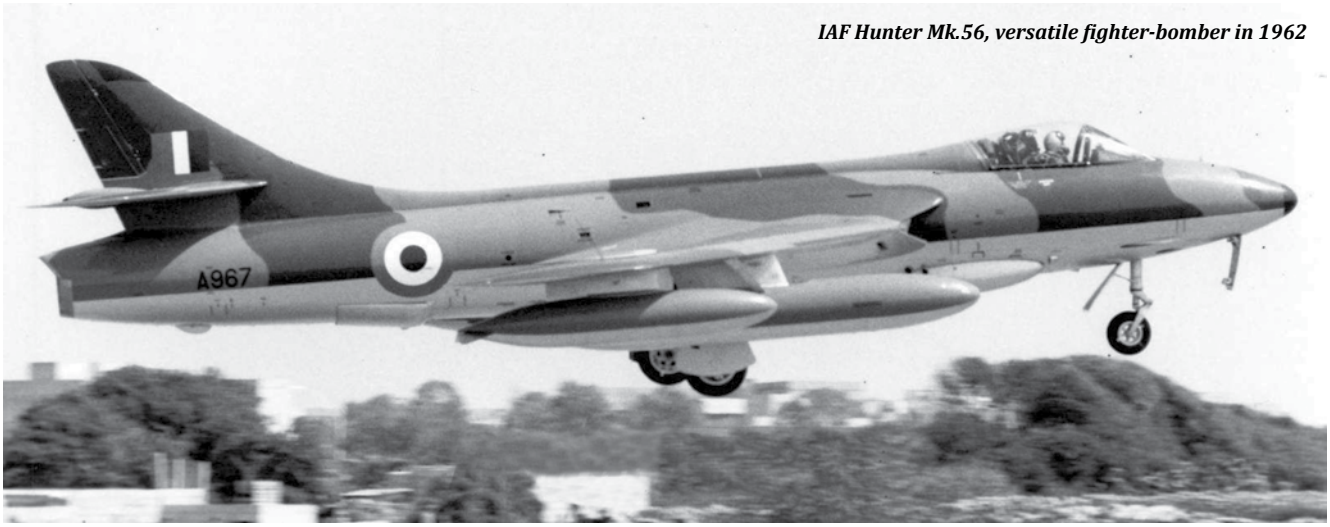
In 1962, the Indian Air Force had about 25 fighter squadrons with about 500 aircraft. After the 1962 war debacle, the IAF postulated a 60 squadron (later pared down to 45) requirement, which was reasonable for the two-front threat it envisaged.

In retrospect, perhaps that was more than required, given the then state of the Chinese PLAAF and the lack of Tibet infrastructure. Nonetheless, there was no way at that time to know that the PLAAF was in stationary state, and that its pilots often got just 20-hours of flying each year. As any force planner knows, aircraft levels have to be decided on the basis of existing and predicted adversary strengths. Enemy limitations such as pilot training and infrastructure can be overcome in far less time that it takes to build a counter force. But there was the psychological angle. The PLAAF then had perhaps 1500 combat aircraft in 1962, expanding to some 2500+ in the 1980s.

The IAF eventually did reach 42 fighter squadrons in the 1990s, and also underwent a vast modernisation of its transport, helicopter, and SAM elements.

The melt down really began in the first decades of the new century and by 2016, the

IAF Hunter Mk.56, versatile fighter-bomber in 1962



Pair of PLAAF J-10s

IAF has gone down to some 30 squadrons, eight of which are MiG-21/27s. To put it kindly, these eight are of limited utility. To put it realistically, it is better to count 25 squadrons and perhaps 500 combat aircraft, as was the force level in 1962.

Pakistan has, at this time, possibly 400 fighters, including the obsolescent F-7s and Mirage III/5s, which will not survive in the current air environment. The US's 2016 annual report gives the Chinese an incredible 2,100 combat aircraft, which is likely three times its useful inventory, but only a portion is deployable in Tibet. Our back-of-envelope estimate is 250 first line fighters by 2020, should China wish. It usually does not wish: it has so intimidated India that it keeps perhaps only a score or so fighters in Tibet from several units on a rotational basis although more arrive in-and-out for exercises.

It must be noted that for an $11-trillion GDP – more than four-times that of India's – the Chinese have been modernising their army and air force very deliberately. Like India, they spend less than 2% on defence except that in real terms, this is four-times India's defence budget. But much of China's budget is going into electronic warfare, air defence networks, air refueling, strategic transport aircraft – and missiles. This is the soft side of military airpower seldom noticed by the media.

So 500 IAF fighters against 250+250 PAF+PLAAF doesn't look too bad. Perhaps a somewhat similar projection has persuaded

Pair of PAF F-16s

Pair of IAF MiG-29s

the Indian Government that 42 squadrons is 'excessive', and that 38 should suffice. Fair enough, 38 could suffice. But the problem is : where are these aircraft that the IAF needs for countering the adversaries ?

Pakistan, for its many problems, inducts 12-15 new aircraft a year. It is difficult to know how many new aircraft the Chinese Air Force (as the PLAAF is now known) gets each year, but it probably is 30+. We get about 12 Su-30s/year. The Indian media is breathless over Rafales, Tejas, FGFAs and so on. Currently these are in the misty realms of the future. Much of the reason for our procurement shortfall is simply money – rather the lack of it. The Government has meanwhile learnt to swallow the cost of new naval warships: $1-billion+ each for destroyers, frigates and conventional submarines, $3-billion+ for midsized aircraft carriers, $200m+ for each P-8I MR/ASW aircraft and so on. In sharp contrast, what the Government has been unable to cough up is the cost of modern fighters, which runs to $100-million each as initial unit cost, so that each squadron will cost about $2-billion. Getting the IAF up to 38 squadrons by 2030 means a commitment of nearly $30-billion straight away. In 2030, 12 Jaguar, MiG-29, and Mirage 2000 squadrons will need replacement – not in stages, but probably right away. The early modernised Su-30 squadrons will also start phasing out. So say, reasonably, $60-billion is needed – without recurring costs – for combat aircraft. Add the recurring costs and we are looking at a commitment of $100-billion plus.

But that figure is just the beginning because we also need hundreds of new transport aircraft, helicopters, air-refuelling tankers, AWACS and special mission aircraft. And we are *still* not done because there's air defense modernisation, ABM, and so on. $150-billion overall by 2030 is not unreasonable, which is in today's prices.

Circa 2066 : 'May the Force be with you !'

The bureaucrats will cry: how can we possibly afford that? Actually, quite easily !

It requires adding 0.4% of GDP to the defence budget. We also need to add similar sums and more for the other Services. The total will then be about 3.2% of GDP. Which, please recollect, is what we used to spend in the 1980s, when our GDP was a fourth of what it is today.

But, will the Government accept the increase from today's 1.8% of GDP to 3.2%? Probably not! And by 2030 China could easily have a $20-trillion economy.

Still, do we really have to spend 3.2%? Actually, we don't. We can accept the subservient status China wants to impose on us, then 1.8% will work. But then, will we have peace? We won't. We'll simply set ourselves up for the next 50-years of demands by our adversaries. Sadly, that's been India's experience for at least 10 centuries, perhaps more. The more we accommodate adversaries on our borders, the more they want.

Parting thought: does the Government of India know that the US military plans *fifty-years ahead*?

Ravi Rikhye

Starfighter and the PAF

Six decades ago, the Pakistan Air Force first 'upped the ante' in South Asian skies when it received Mach 2 fighters in the shape of F-104 Starfighters, leading the Indian Air Force to scramble in search of 'antidotes'. In the event, the Government for India firmed the supply of MiG-21s from the Soviet Union and the race was on.

Although Pakistan was always keen on the F-104 Starfighter and started its first overtures to the USA for these in 1958, it was during President Eisenhower's visit to Pakistan (actually South Asia, as India was the "magnet") in December 1959, that this was first officially raised by President Ayub Khan. Ike and Ayub got along really well – both were senior Army Generals and had much charisma.

When Ike's Boeing 707 'Air Force One' landed in Karachi on 7 December 1959, it was 'escorted' by PAF F-86 Sabres (likewise, IAF Hunters escorted the US Presidential Boeing when it entered Indian skies). The requirement for F-104s was "desirable to strength the Pakistan Air Force in view of the instability of Afghanistan (and Russian economic and military inroads there)" as also "the threat from Communist China to the region (ironic now with China and Pakistan the closet of military allies) and "the imminent political collapse of India" (?!). As for Kashmir, Ayub wanted Ike to use his tremendous influence on Nehru to solve the Kashmir Issue, either by going in for a plebiscite or any other manner.

Despite muffled resistance from the USA, the F-104 issue would not go away ! It was again raised in January/February 1960 but the State Department remained totally negative. Then the US Ambassador in Pakistan, Rountree, was in fact preparing an official note to Pakistan giving a formal "no" when an astonishing 180° turnaround occurred over the weekend. State Department Desk Officer for Pakistan, William Spengler was informed on 3 March 1960 to inform Pakistan that the F-104s had been approved to meet Pakistan's special military requirements!

The key to this clearance were of course the special cold war links between the USA and Pakistan – and particularly the use of Peshawar as a base for the U-2s and the "true function" of the Badaber facility. The Cold War, however, got really 'hot' (for the USA and Pakistan) when in May 1960 an U-2 from Peshawar flying over the USSR to Norway (Gary Powers) was shot down, creating the great crisis. Khrushchev soon warned Pakistan that "Peshawar now had a red circle around it on their maps" – it was a target for nuclear attack !

Much water has flowed down the Indus since then and the only Starfighters to be seen in Pakistan today are at the PAF Museum in Drigh Road, a location where the IAF was actually born in April 1933.

'Ike' and Ayub Khan in ceremonial carriage, circa 1959

H135 performing a demonstration for the international media at Donauworth

TMB'16: Airbus Helicopters at Donauworth, Germany

In the previous issue, Vayu covered its visit to Airbus Defence and Space's (Airbus DS) facilities at Ottobrunn, Germany, in mid-June 2016 as part of the annual Technical Media Briefing (TMB) held by the company. Media from all over the world participated with detailed briefings and factory visits to update us on what all was going on at Airbus DS. Briefings were on the A330MRTT, A400M and the C295 light transport. This article is the second part and takes us to Airbus Helicopters' production lines at Donauworth.

As mentioned in *Vayu IV/2016*, the Airbus Helicopters TMB programme began with an H145M Royal Thai Navy in-flight presentation and an H145M static display briefing by Mark Henning, H145 Programme Governmental business. The company revealed an innovative concept, the 'HForce weapon system' and details were given by Phillippe Kohn, Sales Promotion Manager followed by that on 'New generation light-twin training helicopters – UKMFTS' by Ian Morris, VP Head of defence business Airbus Helicopters UK. At end of the interactive sessions, some hours were spent at the Donauworth FAL (Final Assembly Line), where we were taken to the composite shops, civil and military final assembly lines, NH90 SeaLion FAL as well as a tour of the military MRO activities.

For perspective, Airbus Helicopters is an affiliated company and division of the aviation and aerospace corporation Airbus Group. As one of the largest enterprises in its sector, Airbus Helicopters "develops, sells and maintains the world's' most comprehensive product range of helicopters, starting from the single-engine lightweight class and twin-engine light and middleweight machines to transport helicopters of the 11-ton-class." Situated in Northern Swabia, the industrial site in Donauworth is the German centre of Airbus Helicopters in Germany. With a

Royal Thai Navy H145M before delivery

Tiger at the Final Assembly Line (FAL)

Kuwait orders 30 H225M Caracals

Airbus Helicopters has signed a contract with the Kuwait Ministry of Defence for the purchase of 30 H225M Caracal multirole utility helicopters as well as an associated support and services package, during the recent visit of the French Defence Minister Jean-Yves Le Drian to Kuwait. Kuwait's fleet of H225M Caracals will be used for a wide variety of missions such as combat search-and-rescue, naval operations, medical evacuation and military transportation, to be operated by the Kuwait Air Force and the Kuwait National Guard. The H225M Caracal is the latest evolution of the Super Puma / Cougar family of military helicopters, with more than 500 units delivered worldwide. Kuwait joins other users with 138 H225M Caracal having been ordered so far by France, Brazil, Mexico, Malaysia, Indonesia, Thailand, and Kuwait.

local workforce of around 7,000 employees, Airbus Helicopters is the largest employer in the region and looks back on decades of lively history under the banner of innovation and high-technology.

The foundation of the corporation was actually laid with WMD in 1946, a company specialised in the production of railway carriages and other machines. The engagement of the company in the aviation industry began in 1956, when Siebel-Werke ATG (SIAT) was taken over. In the sector of transportation, both WMD and SIAT were merged and became Messerschmitt-Bölkow-Blohm GmbH (MBB). As soon as the post-war ban to construct aircraft in Germany was lifted in 1956, MBB began to get involved with projects such as Noratlas, Transall, Phantom, Tornado, as well as the Airbus A300 and A310. In 1992, MBB and the French Aerospatiale merged to become the European company Eurocopter. Under the product at designation 'EC', numerous helicopters were developed, based on the foundation of the corporation's predecessors. In January 2014, Eurocopter was renamed Airbus as Helicopters, and in the rebranding process, the helicopter designations shifted from 'EC'to 'H'.

Every part of the twin-engined lightweight helicopter H135 (formerly EC135), from the airframe and the electronics to the blades, is manufactured

The H135 at its FAL

at Donauwörth. [With over 1,200 deliveries since its introduction in 1996, the H135 has become the global market leader of its class.] The production takes place at the local final assembly line. On 16 different stations, specialised teams complete their respective tasks such as installing wiring, the engines and the tail boom. In 2014, an upgraded version of the H135 was introduced. The military variant carries the designation 'H135M'.

The H145 is the successor of the EC145/BK-117 and is the product of a cooperation of Airbus Helicopters and Kawasaki Heavy Industries (KHI) from Japan. While KHI supplies the airframe and electronics, Airbus Helicopters' tasks include construction of the tail boom, dynamic system, installation of the engines and final assembly. In many cases, the entire interior and specialised mission equipment, as for emergency medical services (EMS), is installed on site. As a true multi-role helicopter, the H145 is deployed around

On show, before delivery to customers

the globe for missions in air rescue, law enforcement, VIP-transport or in the offshore segment. The helicopter is also well represented in the United States, where it is used among the armed forces as the light utility helicopter UH-72A Lakota.

The site at Donauwörth also plays a part in the production of Airbus Helicopters' latest development, the H160. The airframe of the 5.5-6 ton class is developed and produced at the local facilities.

Two other important military programmes are located in Donauwörth: the attack helicopter Tiger, as well as the NH90 TTH (Tactical Transport Helicopter) and NFH (NATO Frigate Helicopter). The production of the Tiger's components takes place in Donauwörth, Marignane (France) and Albacete (Spain). Airbus Helicopters Germany is responsible for providing the front-end module and the carbon-made rotor blades, final assembly of the Tiger UHT for the German Army also is at in Donauwörth.

The NH90 is a project of the industrial consortium of Airbus Helicopters, Agusta (Italy) and Stork Fokker (Netherlands). A total of 14 nations have ordered more than 500 helicopters. The NH90 TTH and the NH90 NFH for Germany, as well as the NH90 NFH for Sweden and Belgium are produced in Donauwörth.

Taking advantage of this military support centre, Airbus Helicopters signed an agreement for support of the CH-53G transport helicopters for the German *Bundeswehr*. One of the contracts is the maintenance and overhaul of this model until the year 2030 and beyond. The latest version of the helicopter, the CH-53GA, is equipped with new generation avionics, communication and weaponry. This military support centre guarantees the comprehensive support and service for nearly every rotorcraft of the German Armed Forces.

The HForce Generic Weapon System

Airbus Helicopters has unveiled a common weapons system for its range of civil-derived military helicopters, giving operators an inexpensive upgrade option. Weapons selected for the 11t-class platform, include an FN Herstal 12.7mm machine gun, Nexter 20mm cannon and 70mm unguided rockets. Integration of guided weapons will be complete by this year-end, allowing operators to select the helicopter in a baseline configuration without weapons, yet retain the ability to rapidly upgrade them.

The company has recently completed firing tests with HForce, a generic weapon system in development for the company's helicopter range. The innovative system, which includes a central core unit, Thales' Scorpion monocular helmet mounted sight display (HMSD), an electro-optical system (EOS) from Wescam as well as gunner armament weapon grips and weapon pods, has been undergoing testing. In May-June 2016, a firing campaign involving an HForce-equipped H225M took place on a dedicated range in Belgium, demonstrating performance of HForce with ballistic weapons, including 12.7 mm guns, 70 mm rockets as well as 20 mm cannons.

"This important milestone, achieved on time, demonstrates that HForce achieves excellent results above specifications, and that it provides a real added value in terms of target tracking and acquisition for day or night missions, thanks to the EOS and HMSD", said Jean-Luc André, HForce Programme Manager.

HForce, whose development was launched two years ago, is an incremental, affordable, plug n' play weapon management system that can be fitted onto any military version of Airbus Helicopters commercial range (H125M, H145M, H225M). "HForce is designed to meet the requirements of defence agencies seeking light attack mission capabilities or a complement to their existing fleet of specialised attack helicopters," according to the Company.

The Airbus Commercial Forecast

"Over 33,000 new airliners by 2035"

The A350XWB during a demo flight at the Farnborough Airshow 2016

Over the next 20 years (2016-2035), according to Airbus' Global Market Forecast, passenger traffic will grow at an average 4.5% a year, driving a need for over 33,000 new aircraft above 100 seats (32,425 passenger and 645 freighters greater than 10 tonnes) worth US$5.2 trillion. By 2035, the world's aircraft fleet will have doubled from today's 19,500 aircraft to almost 40,000 with some 13,000 passenger and freighter aircraft replaced with more fuel efficient types.

Urbanisation and increased wealth in emerging economies, particularly in Asia, is powering this air traffic growth. With a combined population of over six billion people, these economies will grow at 5.6 percent per year and the propensity to travel will triple to 75 percent of its population. Within the next 10 years, China's domestic air traffic will become the world's largest. In economies like Western Europe or North America, air traffic growth will be 3.7% percent.

Thai's 1st A350 XWB in maiden flight

The first A350 XWB for Thai Airways International (THAI) has made its maiden flight, THAI will acquire a total of 12 A350-900s with four on direct order and eight on lease, the airline operating these aircraft for long range as well as select regional services.

Jetblue orders 30 additional A321s

New York-based JetBlue Airways has amended its purchase agreement with Airbus to include an additional 15 Airbus A321ceo (current engine option) and 15 A321neo (new engine option) aircraft. The airline, which already operates A321s, has not yet announced its engine selection for the newly ordered aircraft. Beginning in 2019, JetBlue has the flexibility to configure the New Engine Option aircraft to the Longer Range version of the A321 – the A321LR – JetBlue currently operates a fleet of 160 A320 Family aircraft, including 130 A320s and 30 A321s. Including the latest order the airline's backlog of Airbus aircraft comprises 116 airliners: 25 A320neo, 31 A321ceo, and 60 A321neo aircraft.

Allegiant orders 12 Airbus A320ceo

Las Vegas, Nevada-based Allegiant Travel Company has signed a purchase agreement for 12 Airbus A320ceo (current engine option) aircraft. This deal marks the first time the low-cost airline has purchased new aircraft from any manufacturer. Each will be powered by CFM56 engines from CFM International. The company's current fleet plan is focused on a transition to all Airbus aircraft including a mix of previously-owned aircraft along with those included in this deal.

Whilst GDP remains a key driver in traffic growth, Airbus sees 'private consumption' (a component of GDP) becoming a more significant economic variable on some important flows including domestic China and domestic India. Middle classes in emerging markets will double to 3.5 billion people by 2035.

Globally, by 2035, 62 percent of world population will be city dwellers and the number of aviation mega cities will rise from 55 to 93 by 2035. These centres of wealth creation, 47 of which are already schedule constrained airports, will account for 35 percent of world GDP. In 20 years the number of long haul passengers travelling to, from, or via aviation mega cities, will more than double to 2.5 million every day!

Airbus' global services business which today spans six customer support centres, and 14 training centres, is set to expand further as the next 20 years sees a requirement for some one million pilots and engineers (560,000 new pilots, 540,000 new engineers) to fly and maintain the new aircraft.

"While established European and North American markets continue to grow, Asia-Pacific is the 'engine powering growth' in the next 20 years. China will soon be the world's biggest aviation market and together with emerging economies, further population concentration, and wealth creation, together these will help to fuel strong air traffic growth," said John Leahy, Airbus Chief Operating Officer, Customers. "We are ramping up production to meet market demand for our leading aircraft products and we will also ramp up our customer service offerings to meet the increasing demands of air transportation."

In the widebody market, Airbus looks at a trend towards higher capacity aircraft and forecasts a requirement for over 9,500 widebody passenger and freighter aircraft over the next 20 years, valued at some US$2.8 trillion. This represents 29% of all new aircraft deliveries and 54% by value. Most widebody deliveries (46 percent) will be in the Asia Pacific region. In this segment, Airbus' A330, A330neo, A350 XWB and the A380 offer "the most comprehensive widebody product range between 200 and above 600 seats".

In the single aisle market, where the A320 Family and the latest generation A320neo Family are firmly established as "global market leaders", Airbus forecasts a need for over 23,500 new aircraft worth US$2.4 trillion. This represents 71 percent of all new units. Asia Pacific will take 39 percent of these deliveries.

Traffic growth is leading to larger aircraft sizes which have grown by over 40 percent since the 1980s as airlines select larger aircraft or up-size existing backlogs. Larger aircraft like the A380, combined with higher load factors, make the most efficient use of limited airport slots and contribute to rising passenger numbers as has been seen at London's Heathrow Airport. A focus on sustainable growth has enabled fuel burn and noise reductions of to fall by at least 70 per cent in the last 40 years. This trend continues with innovations like the A320neo, the A330neo, the A380 and the A350 XWB.

Vietnam is now Airbus Country !

Vietnam Airlines to acquire 10 more A350 XWBs

Vietnam Airlines has signed a Memorandum of Understanding (MOU) with Airbus for 10 more A350-900 aircraft, the aircraft to be used by the airline on non-stop flights to the US, beginning with services between Ho Chi Minh City and Los Angeles. The MOU was signed in Hanoi by Duong Tri Thanh, President and CEO of Vietnam Airlines, and Fabrice Brégier, Airbus President & CEO.

Vietnam Airlines has became the first airline in East Asia and the second in the world to operate the A350 XWB. The carrier already has four aircraft in service, with another 10 on firm order for future delivery. The additional 10 aircraft covered by this MOU will enable Vietnam Airlines to operate non-stop to the US West Coast, carrying 305 passengers in a three class premium layout.

Vietjet expands with 20 A321s

Vietnam's Vietjet has placed a firm order with Airbus for 20 A321 single aisle aircraft to meet growth demand on its domestic and regional network. The purchase agreement, covering 10 A321ceo and 10 A321neo, was signed in Hanoi by Vietjet President and CEO, Nguyen Thi Phuong Thao and Fabrice Brégier, Airbus President & CEO, during the state visit to Vietnam of François Hollande, President of France, and witnessed by Mr Hollande and Tran Dai Quang, President of the Socialist Republic of Vietnam.

In addition to the new order, Vietjet and Airbus have also finalised an agreement for the manufacturer to provide training services for flight crew and maintenance personnel at the airline's new facility in Ho Chi Minh City. This will replicate Airbus courses at the facility identical to those offered at the manufacturer's own training centres. Vietjet began services at the end of 2011 and now operates a fleet of 40 A320 Family aircraft. Following the current announcement, the airline has placed firm orders with Airbus for a total of 119 A320 Family aircraft, including 54 A320s and 65 A321s.

Jetstar Pacific orders A320ceos

Vietnam's Jetstar Pacific Airlines has finalised a purchase agreement with Airbus for 10 A320ceo aircraft, the contract following an MOU announced earlier this year and signed recently in Hanoi by Le Hong Ha, Chief Executive Officer of Jetstar Pacific and Fabrice Brégier, Airbus President and CEO.Based in Ho Chi Minh City, Jetstar Pacific is a joint venture between Vietnam Airlines (70%) and the Qantas Group (30%). The order from Jetstar Pacific marks the first direct purchase by the airline from Airbus. The aircraft will join an existing fleet of 12 leased A320 Family aircraft flying with the airline on domestic and regional routes.

Boeing's Services Business set to grow in India

The services and support market is a significant growth area for India and Boeing is working with the Indian Air Force and Indian Navy to provide training and support of Boeing aircraft such as the P-8I, C-17 and the Head of State aircraft. Earlier this year at Defexpo, Vinayak Rajagopal, Director of Global Services & Support (GS&S) in India, explained that the advantage of Boeing's services business is that Boeing can draw upon 100 years of experience in aviation to "create, develop, produce and support solutions for our customers."

Boeing's services business is one of the fastest growing businesses within the company with the turnover of nearly $10 billion, 12,500 employees in 290 sites across 28 countries; and that the company is focused on three key areas - uncompromising service; local presence and global reach.

It is this focus that has enabled Boeing to ensure that the customers' fleet achieves the highest levels of mission readiness for the aircraft to be available for military, surveillance and humanitarian relief missions with the best trained crews.

Over the last three years, the Indian Air Force's C-17 aircraft and the Indian Navy's P-8I aircraft have demonstrated an excellent record in supporting the missions they have been deployed for. The Indian Air Force and Indian Navy have extensively deployed their fleet for missions and expressed satisfaction about the operational readiness of both aircraft.

Boeing has been supporting the IAF's C-17 Globemaster III fleet through the C-17 Globemaster III Integrated Sustainment Program (GISP) contract. This has resulted in unprecedented levels of mission capable rates that enable the IAF and IN. Boeing is currently preparing for delivery and support of Apache and Chinook helicopters for the IAF.

C-17 Globemaster III Support: Driving Up Mission Readiness Rates

The high mission readiness rates are a result of Boeing's C-17 GISP, "virtual fleet" arrangement ensures mission readiness by providing all C-17 customers access to an extensive support network for worldwide parts availability and economies of scale, making the C-17 more affordable to own and operate. The C-17 GISP is a system-level partnership with the US Air Force, where the customer pays for readiness, rather than specific parts or services.

Rajagopal explained that the C-17 GISP programme has become a model for the future of sustainment. Boeing is held accountable to achieve sustainment performance metrics and is paid accordingly. Boeing is responsible for supply support, supplier management, technical manual support, maintenance, modifications and upgrades, logistics engineering services and field support services. Boeing personnel come into contact with the aircraft every day in the field, working alongside personnel to keep the C-17 fleet flying with the best availability in airlift history.

C-17 Training

With the establishment of a training facility in Gurgaon by Boeing and Mahindra Defence Systems in July this year, Indian Air Force air crews can now receive training on the full motion simulator with advanced simulation, courseware and computer-based training to practice the complete range of tasks required for military airlift operations and humanitarian missions, along with other scenarios such as aerial refueling and emergency procedures. The facility includes weapons systems and loadmaster station trainers that can be employed individually or networked together to rehearse complete missions. The simulator's flight deck supports training with night vision goggles for comprehensive mission training.

Training is provided through local and multi-site simulations for added realism and more robust training.

Pratyush Kumar, President, Boeing India, explains that the centre, in partnership with Mahindra Defence, is another example of the steps we are taking to contribute to the building of a holistic aerospace ecosystem in support of Make in India. "This demonstrates our commitment to provide reliable support and services for our customers throughout the lifecycle of a product," Kumar said.

Initial qualification training of Indian Air Force C-17 crews was conducted by the US Air Force at Joint Base Charleston

An IAF Boeing C-17 Globemaster III

Defence Minister Parrikar visits Chinook facility

The Ministry of Defence finalised its order with Boeing for production, training and support of 22 AH-64E Apache attack helicopters and 15 CH-47F Chinook heavy-lift helicopters in September 2015. A year later, Defence Minister Manohar Parrikar visited the company's Philadelphia plant where the Chinook helicopters are manufactured for India, the US Army and other forces around the world.

in South Carolina. A total of 100 Indian Air Force airmen received instruction from the 373rd Training Squadron Detachment 5 on how to operate India's C-17 Globemaster IIIs. The training included classroom time as well as simulator training.

Supporting the Indian Navy's P-8I Fleet

Boeing supports India's P-8I fleet by providing spares, ground support equipment and field service representative support. Boeing's integrated logistics support enables the highest state of fleet readiness at the lowest possible cost and has demonstrated reduced ownership costs and decreased cost per flight hour over multiple platforms.

More than 7,000 Boeing 737s are in active service all over the globe enabling all derivative aircraft, including the P-8A Poseidon, to benefit from this uncommon economy of scale for sustainment and support needs. By leveraging unique "One Boeing" capabilities, Boeing's services business is deploying a sustainment solution for P-8I that draws on synergies from Commercial Airplane Services, including its subsidiary, Aviall, while leveraging the economy of scale unique to commercial derivative aircraft, specifically the 737, the world's most prolific commercial aircraft, in service and in production.

Boeing Chinook and Apache

Initial P-8I training for Indian Navy pilots, mission system operators and maintenance technicians that will operate and maintain P-8I aircraft was done in Seattle. The programme included a combination of flight, classroom and lab training as well as real-world simulation experiences that can reduce total ownership costs. Boeing has trained more than 110 Indian Navy professionals, including five pilot crews, five mission crews and a number of flight signalers and observers.

As the original equipment manufacturer, Boeing is uniquely positioned to provide training devices that most accurately simulate P-8 aircraft and mission systems and stay current with aircraft configuration. Boeing's training provides a full range of equipment, software, courseware, personnel and logistics. Boeing is currently providing P-8 aircrew and mission crew simulators for the US Navy. The benefits of these simulator-based training include a reduced number of training flights, lower cost of operation (less fuel and maintenance required for live aircraft), and reduced use of limited aircraft. Training provides high level of crew readiness and proficiency for multiple mission profiles.

With the induction of the Apache and Chinook in the coming years, Boeing anticipates additional opportunities in training of aircrew and maintenance courseware development and support. Boeing been providing simulation based training solutions to the US Army and several other international customers operating the AH-64 Apache and CH-47 Chinook helicopters.

With inputs from Boeing

UAV/UCAVs

Smarter Eyes in the Skies

This article reviews some of the developments and the technological spinoffs that are likely to have a profound impact upon uninterrupted 24/7 gathering of real time strategic intelligence, surveillance, and reconnaissance data.

Platforms

The **X-37B** or the Orbital Test Vehicle mystery aircraft of the US Air Force has completed over one year in orbit and it is not known when it will recover. The X-37B programme has been shrouded in mystery since its inception some time in 1999 as a NASA programme. The X-37B has a wingspan of 4.5m, a length of 8.9 m, a height of 2.9m and a launch weight of 4990 kg, is powered by GaAs solar cells and lithium-ion batteries after it is boosted

GA-ASI and NLR Collaborate

GA-ASI and the Netherlands Aerospace Centre (NLR) have signed an agreement to support expanded operational approval for remotely piloted aircraft (RPAs) to fly in non-segregated European airspace. "NLR's tremendous airspace and air traffic control modeling and simulation capabilities allow us to test and validate civil airspace integration concepts for medium-altitude long-endurance [MALE] unmanned aircraft systems," stated GA-ASI CEO Linden Blue, "NLR's contribution to PredatorB's integrated 'Detect and Avoid' system helps further international acceptance of MALE flight in civil airspace worldwide. While PredatorB is currently operational in segregated airspace in Europe, this collaboration is intended to expand operations into non-segregated airspace.

Certifiable Predator Bs for RAF

The UK Ministry of Defence (MoD) has chosen the General Atomics Aeronautical Systems (GA-ASI) Certifiable Predator B (CPB) remotely piloted aircraft system, with some specific modifications, to fulfill its future armed Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) requirements. MoD selection of CPB follows the '2015 Strategic Defence and Security Review' and announcement of the UK government's intention to replace the Predator B/MQ-9 Reaper. CPB has been selected as the only viable option capable of meeting the UK Protector programme's key user requirements, which include operations in both controlled and uncontrolled airspace. GA-ASI is undertaking an independent research and development (IRAD) effort to design, develop, and produce the CPB, a variant of the Predator B RPA that is fully compliant with NATO's UAV System Airworthiness. Construction has begun, with fuselage integration currently under way, followed by wing and tail integration planned for late summer. Flight testing is scheduled for late 2016.

into space. It can remain in orbit for periods of over one year. As per US Air Force fact sheet the mission of the X-37B Orbital Test Vehicle, or OTV, is "an experimental test programme to demonstrate technologies for a reliable, reusable, unmanned space test platform for the US Air Force. The primary objectives of the X-37B are twofold: reusable spacecraft technologies for America's future in space and operating experiments which can be returned to, and examined, on Earth. It states further that OTV missions till now have spent a total of 1,367 days in orbit, "successfully checking out the X-37B's reusable flight, re-entry and landing technologies." As per US Air Force fact sheet, some of the technologies being tested include advanced guidance, navigation and control, thermal protection systems, avionics, high temperature structures and seals, conformal reusable insulation, lightweight electromechanical flight systems, advanced propulsion systems and autonomous orbital flight, reentry and landing.

Global Hawk exceeds 200,000 Flight Hours

Northrop Grumman's autonomous Global Hawk unmanned aircraft system (UAS) has surpassed 200,000 flight hours, reinforcing its status as the most "effective high altitude, long endurance intelligence gathering aircraft in the world." The US Air Force's Global Hawks logged 88 percent of the 200,000 flight hours with the remaining hours flown by NASA Global Hawks, Germany's Full Scale Demonstrator and the Navy's broad area maritime surveillance aircraft systems. Global Hawks operate at altitudes up to 60,000 feet for more than 30 hours, surveying thousands of square miles on a single mission. Global Hawk carries a variety of sensor payloads that allow military commanders to gather near real-time imagery and use radar to detect moving or stationary targets on the ground. The system also provides airborne communications and information sharing capabilities to military units in harsh environments.

FAA approval for Predator C Avenger

GA-ASI's Predator C Avenger RPA system has received a Federal Aviation Administration Experimental Certificate (EC) that allows it to perform routine operations in the US National Airspace System. The Avenger is designed to undertake high-speed, long-endurance missions over land or sea, has an endurance of 15 hours, can support a wide range of sensors and weapons loads and has been designed to carry an all-weather GA-ASI Lynx multimode radar, EO/IR sensor, and a 2,000-pound Joint Direct Attack Munition (JDAM), thus offering Intelligence, Surveillance, and Reconnaissance (ISR) and precision-strike capability. GA-ASI plans to start flight testing an extended-range Improved Avenger in September 2016. Increased wingspan of 76 ft. will extend the aircraft's endurance to 20 hours.

The **VULTURE** is an acronym for DARPA's Very-high altitude, Ultra-endurance, Loitering Theatre Unmanned Reconnaissance Element programme. The objective of the Vulture programme was to enable an uninterrupted ISR and communication missions spanning five years or more by remaining airborne at very high altitude. The VULTURE was envisaged to operate as a single platform, or as a formation of multiple aircraft, or as a constellation providing infrastructure augmentation/recovery. The project transformed into Boeing/Phantom Works SolarEagle (VULTURE II) project, which aimed to reach that five-year endurance mark with its 120m wingspan but the project was cancelled in 2012.

The Lockheed Martin **High Altitude Airship (HAA)** is an un-tethered, unmanned lighter-than-air vehicle designed to operate above the jet stream in a geostationary position to deliver persistent station keeping as a surveillance platform, telecommunications relay, or a weather observer. It will provide the military with ever-present ISR and rapid communications connectivity over the entire battle space. The airship is estimated to survey a 600-mile diameter area and millions of cubic miles of airspace.

Global Hawk is the long-range, high-altitude ISR UAV of the USAF, can fly up to

L-3's MX-15D for GA-ASI's Predator XP

L-3 Communications' WESCAM division has received multiple orders from General Atomics Aeronautical Systems (GA-ASI) for its MXTM-15D electro-optical and infrared (EO/IR) designator systems for "an international military customer." L-3's equipment will support medium-altitude covert intelligence, surveillance and reconnaissance (ISR) missions carried out by GA-ASI's Predator XP remotely piloted aircraft (RPA) system. L-3's imaging systems range in size from 8 inches to 25 inches in diameter and provide high-resolution, stabilised full-motion intelligence in support of low-level tactical to high-altitude, ultra-long-range persistent missions. L-3's MX-15D has been engineered with large-aperture, long focal length optics and patented four-axis gimbal technology.

32 hours at altitudes upto 60,000 feet, with a range of 12,300 nautical miles, providing imaging and signals intelligence, as well as communications support to US militaries around the world. It is battle proven and gives near-real-time, day and night, all weather high-resolution imagery of large geographical areas.

MQ-4C Triton: The US Navy will continue with Triton, a development of the Global Hawk, that can stay aloft for over 24 hours at 60,000 ft., with speeds up to 610 km/h. Its surveillance sensor is the AN/ZPY-3 Multi-Function Active Sensor (MFAS) X-band AESA radar with a 360-degree field-of-regard, capable of surveying 7,000,000 sq km of sea. It utilises the radar in inverse synthetic aperture mode to identify a target in any weather condition and take high definition radar pictures, then use the advanced image and radar return recognition software of the onboard automatic identification system (AIS) for classification.

United Kingdom orders additional Zephyrs

The United Kingdom's Ministry of Defence has announced its intention to exercise an option for the manufacture and operation of a third Airbus Zephyr S High Altitude Pseudo-Satellite (HAPS) unit. Flying at some 65,000ft, the ultra-lightweight Zephyr S "is uniquely capable of providing persistent surveillance or communications over the same area of land or sea for weeks at a time without landing." The precise purposes for which the UK MoD will use its Zephyrs have not been disclosed.

Operating exclusively on solar power and flying above the weather and civil air traffic, the latest generation Zephyr S has a wingspan of 25 metres, is 30% lighter and can carry 50% more batteries than its predecessor. This enables the Zephyr S to carry heavier payloads for its surveillance and communications roles. The Zephyr S HAPS is designed to fly continuously for over a month if required before landing, being refurbished, and operating once more.

Sensor Packages

In December 2015, the US DOD confirmed that the Gorgon Stare wide-area airborne surveillance (WAAS) system had been incorporated in the Reaper MQ-9 UAV of the US Air Force missions flying over Afghanistan. The basic configuration of Gorgon Stare consists of five monochrome charge-coupled device (CCD) daylight cameras and four thermal cameras built into a 25-inch EO/IR turret with a separate pod for data links. The advanced version of the above is the Autonomous Real-Time Ground Ubiquitous Surveillance Imaging System (ARGUS-IS).

The ARGUS-IS, is a DARPA project contracted to BAE Systems and is a wide-area persistent surveillance system. Its camera system utilises hundreds of mobile phone cameras in a mosaic to video and auto-track every moving object within a 36 square mile area. The ARGUS-IS provides military users an "eyes-on" persistent wide area surveillance capability to support tactical users in a dynamic battle space or urban environment. It is understood that ARGUS can be easily deployed on UAVs like Predator.

The 'brains' for handling of the immense amount of data gathered by the advanced surveillance cameras are encompassed in a software programme called *Persistics* developed by Lawrence Livermore National Laboratories. Fundamentally, this is a data compression programme, which can compress the raw wide area video data from aircraft and UAVs 1000 times and achieve a reduction of pre-processed images by a factor of ten. Persistics compresses data that are essentially background data including jitter, static images of the background etc while retaining the images of military interest. The system functions by carrying out video stabilisation using 'pixel-level dense image correspondence'; background image compression; aligning image positions obtained from different cameras, and output images of moving objects with sub-pixel resolution.

Armed Forces are moving rapidly towards gathering of strategic intelligence, surveillance, and reconnaissance data. The processing of such voluminous data is also being undertaken by advanced techniques utilising artificial intelligence to a large extent. Nevertheless, the 'kill-loop' still takes considerable time from detection by the unmanned vehicles in the sky to activation of the armed response. Time is therefore ripe for the long endurance UAVs to start deploying armament on their pods. However, automation of drones to execute the kills on their own, without a human in the loop, is still some years away !

Sanatan Kulshrestha, CLAWS

Elbit Systems Introduces Skylark C

Elbit Systems has developed the Skylark C, a new highly autonomous Mini Unmanned Aircraft System (Mini-UAS) specifically designed and built for maritime applications. Based on the Skylark I Mini UAS, which are fully operational and in use by numerous customers around the world, the new Skylark C transforms and extends the operational capabilities of its land-based counterpart into an organic maritime Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) asset. As a maritime vessel organic asset, Skylark C provides the capabilities to inspect maritime activities from a safe distance, observe targets from a bird's eye view, perform reconnaissance over coastal areas and perform continuous covert surveillance, thus extending the vessel's ISR capabilities with respect to range, rate and quality of information obtained.

"Mission effective, with highly autonomous flight capability," Skylark C incorporates an electrically-propelled air vehicle with a very low visual and acoustic signature, making it "an ideal solution for covert operations such as special naval operations, border security, anti-terrorism and anti-piracy operations." The aerial vehicle utilises Elbit Systems' UAS technology and know-how, featuring an advanced inertial navigation system (INS) and a stabilised electro-optical (EO) payload with a high resolution thermal imager and colour daylight camera that enables continuous day/night monitoring in diverse weather conditions.

The UAV payload market

In a new report available on ASDReports, *Drone Payload Market by Type (EO/IR, Cameras, SAR, Sigint, Elint, Comint, MPR, Laser Sensors, CBRN Sensors & Optronics), End-User (Defence & Commercial), and Region - Global Forecast to 2021*, the global drone payload market is estimated to be $ 3.63 billion in 2016 and is projected to reach $ 7.72 billion by 2021, registering a CAGR of 16.25% during the forecast period.

A number of factors, such as advancement in sensor technology and increasing focus towards using economical solutions for surveillance, are expected to drive the UAV payload market. On the basis of type, the synthetic aperture segment is estimated to lead the drone payload market, and is expected to continue its dominance during the forecast period. The market for SAR is primarily driven by the need for economical surveillance solutions with enhanced performance abilities for defense applications, in terms of identifying potential threats.

The drone payload market has been segmented and analysed on the basis of end user, both defence and commercial. The drone payload market for commercial is expected to register significant growth owing to increasing use of UAVs in civil applications, and relaxing of various regulatory norms. North America is expected to lead the drone payload market thanks to increasing focus of the US Department of Defence (DOD) on using unmanned aerial vehicles for surveillance, and battle assessment and target acquisition-related tasks. This is owing to the low cost of operations as compared to manned aircraft, which are expensive to procure and entail higher risks.

Major players in the drone payload market are SZ DJI Technologies (China), Lockheed Martin (US), Elbit Systems from Israel, Northrop Grumman Corporation (US), Thales Group (France), and 3D Robotics (US), among others. On the basis of type, the drone payload market has been segmented into EO/IR, cameras, synthetic aperture radar (SAR), signal intelligence (SIGINT), electronic intelligence (ELINT), communication intelligence (COMINT), maritime patrol radar (MPR), laser sensors, CBRN sensors, optronics, and others.

Hermes 450 demonstrated at North Dakota UAS Field Day

Elbit Systems of America, a subsidiary of Elbit Systems Ltd, along with its local partners, hosted an Unmanned Aircraft Systems (UAS) Field Day recently to highlight its recent Hermes 450 flights over North Dakota. Equipped with advanced sensors and high resolution cameras, such as the Vision Map A3 Edge and the Elbit Systems Compass EO/IR real time sensor, the Hermes 450 is capable of covering 40,000 acres in an hour and can remain airborne for 17 hours.

Elbit Systems of America, a US company headquartered in Fort Worth, Texas, has been operating from the Hillsboro Regional Airport for many months where it has flown multiple precision agricultural-related flights. In collaboration with North Dakota State University and the Northern Plains UAS Test Site, Elbit Systems of America has worked with select local farmers to gather and analyse data for crop management improvement, increasing efficiency and enabling greater yield.

Aerial threats and Air Defence

Russian ZSU-23/4

Prominence of ground-based systems

During the American Civil War, in August 1861 Union Forces used a balloon to observe Confederate Forces massing against Washington. Using a rifled 6 pounder, the Confederates fired several rounds at the balloon. They scored no hits but the fire caused the balloon to be brought down. Since the time when such balloons were used to observe or throw bombs or other hostile weapons against ground troops, the counter to these actions have always been keeping pace against such hostile air action – as natural fallout. Balloons gave way to very sophisticated flying machines, which could cause awesome devastation, and as a counter, the 6-pounder has eventually been replaced by a family of surface-to-air weapon systems consisting of radars, guns and missiles, which when deployed in a coordinated manner, can sanitise an expanse of air space for a particular period of time against unfriendly aerial activity. Air power and the nature of aerial threat is undergoing a dynamic change. Today, air power no longer connotes manned combat aircraft alone, but is shifting towards an increasing number of unmanned platforms. The air threat matrix, wherein the use of Beyond Visual Range (BVR) weapons have become a rule rather than exception and is now defined by players like attack helicopters, Unmanned Aerial Vehicles (UAVs), cruise and ballistic missiles, electronic warfare, anti-radiation missiles, smart, intelligent and precision guided munitions and in times to come, space based weapon platforms, will certainly dominate the battlefield.

Technology has made a cutting edge impact in all aspects of air power, transforming into 'aerospace power.' Therefore, not only is there imperative need for land based air defence of the country's air space but also the need for integration of effort in terms of management and employment of all air defence resources. Air defence, at the national level, necessitates an overall integrated approach in order to perform its intended role. In India, although the Indian Air Force is overall responsible for air defence of the nation, the Army, Navy and the Air Force have their own air defence branches with own weapons.

Russia's Tunguska M1

Requirements of Air Defence

Since ground, air and naval combat forces must be allowed maximum freedom of manoeuvre, therefore must be able to ensure that multiple aerial threats in a particular geographical area are taken care of in the short span of the few seconds available for engagement. There is a requirement for shifting layers, mobility, and varying ranges to provide flexibility in air defence, which will also have to be tiered to provide multiple punishment at area and point defence levels. Air defence will have to be lethal and capable of engaging at enhanced ranges with a mix of guns and missiles with added capability of handling multiple targets. These measures should also be able to have a networked grid of long and medium range surface to air missiles (SAMs) facilitating 'plug and play' operations to provide area air defence cover to all assets. The system must also have a modularly–designed identification of friend and foe system which can be compatible with all users of air space so as to prevent fratricide. It must have gap free surveillance and ability to act against non-state actors, capability against unconventional measures and finally an apex organisation for consolidated control of all air defence assets and seamless integration with theatre missile defence. Having all these in the air defence organisations would naturally make such organisations very complex and consequently more expensive. It would, of course, be prohibitive for any country to have state-of-the-art air defence always and all the time. Thus, the solution has to be a judicious mix of different technologies with updates and upgrades.

Layers of Air Defence

As mentioned earlier, air defence has to be layered and tiered to ensure that its assets in terms of static, semi static and mobile assets survive aerial threats. The outermost layer is usually provided for by an air force in terms of interceptors supplemented by Long Range Surface to Air Missiles (LRSAMs). These are additionally buffeted with Medium Range SAMs (MRSAMs), Very Short Range Air Defence Systems (VSHORADS) and finally the Close–In Weapon System (CIWS) constituting rapid firing guns with programmed ammunition or a mix of guns and missiles as per importance of the assets being protected. The LRSAMs have a chain of radars and control system providing early warning information. These are deployed to ensure that the air threats are taken care of at the longest distance. Similarly, the navy also has its concentric air defence or defence in layers with various types of ships each of

DRDO's Akash on launch

which has various air defence weapons of different ranges and capability.

Land-based Phalanx Weapon System (CIWS) is part of the US Army's Counter Rocket, Artillery and Mortar systems used to detect and destroy incoming rounds in the air before they hit their ground targets. It also helps provide early warning of attacks. Therefore, it is important that we look at what is available in all these segments with a particular interest to the available air defence equipment in our neighbourhood.

Point Air Defence

Point air defences are measures adopted to provide air defence of a single object or a small area, e.g. a ship, bridge, building or an airfield usually against aerial threats. These weapons have lesser range, greater flexibility and are within sight of the vulnerable point that it protects. Point air defence is generally provided with close-in weapon systems on ships and airfields or a mix of land based very short range SAM systems, for example a combination of Polish Loara or Rheinmetall Skyshield gun system with AHEAD ammunition alone or in combination with man portable missile systems like RBS 70NG, Stinger or Igla S. These are cheaper compared to long range air defence missiles and are well suited to provide terminal stage air defence both against aircraft and helicopters as well as against mortars and missiles. However, such systems will have to be deployed in important points where there is an aerial threat. There is a school of thought propagating that "there is no need for guns in the modern air defence arsenal and all guns need to be replaced with missiles". Still, what is required is that the final stage of air defence or point defence or the final CIWS should be a gun-missile mix to incorporate all advantages of 'non jammable' guns. Today, many countries have the outdated L70/40, Zu-23 and ZSU-23/4 Schilka guns which need to be replaced with more efficient guns systems such as the Skyshield, Loara, German Mantis and their self-propelled counter parts like the Gepard, Tunguska M1, Pantsir or the South Korean Doosan systems. Such gun systems generally engage in the range of 4 to 6 km and the missiles in the range of 6-10 km, thus providing two layers of defence against aerial threats. In fact, the Russian Tunguska and the Pantsir are gun-missile systems mounted on a single combat vehicle and can be very effective against low flying aerial threats in the mobile battle field.

Pakistan's point air defence consists of limited quantities of modern radar controlled 35 mm Oerlikon guns with Skyguard radars and RBS-70 SAMs with Giraffe Radars in this segment. These are deployed to protect vital installations and air assets. Similarly the mobile assets have point air defence from a weapon mix of optically laid, manually controlled 37 mm, 14.5 mm guns and RBS-70 missiles mounted on M-113 APCs. Apart from this, Pakistani Army air defence also deploys older version shoulder fired infra-red (IR) or laser beam riding missiles like the SA-7, Redeye, Chinese made HN-5, indigenous Anza or US–made Stinger missiles independently or along with a number of 14.5mm guns for protection.

Chinese People's Liberation Army (PLA) air defence however, has much better equipment in terms of quantities for point air defence. The PLA uses a mix of guns and short range SAMs or two varieties of SAMs for point air defence. In terms of guns, the PLA has towed 57mm and twin barreled 37mm guns. The gun missile mixes are mostly vehicle or track–based. The Type 95 system has the CLC-1 search radar with four 25 mm guns mounted on the vehicle along with four QW2 heat seeking missiles. Along with this, they have CLC-2 search radar based on a separate vehicle. The system has been developed to bring about an equivalent of the Russian ZSU-23/4 Schilka weapon system.

Next in line is the latest 8x8 vehicle version called Lundun 2000 which has a Type 730B gun considered to be a copy of the Goalkeeper 30mm CIWS and is also thought to be a copy of the Avenger Cannon on the US A-10 aircraft. Recently, an addition of six TY90 SAMs is aimed at equating it to Russian's Pantsir in terms of

role. The system is equipped with a counter rocket, artillery and munition (C-RAM) role by the PLA. There is a Type 90 variant of the 35 mm guns initially licensed by Oerlikon which has been transformed into a radar controlled gun system with good mobility by mounting it on a heavy mobility vehicle plus a Type 902 radar system. Similarly, the Chinese are reported to have cloned the Crotale SAM in their version called HQ7B/FM 90 mounted on a 6x6 vehicle with the missiles reported to have a range greater than 10 kms. The HQ6/HQ61 again are employed as point defence SAMs. These have now been modified to the LY60/HQ64 system which is reported as a clone of Italian Selenia's (Alenia) Aspide MkI SAM system with greater range of 20 kms. A copy of AN/TWQ- 1 Avenger of US is thought to be the FB6A system which again uses TY90 SAMs. Then there is the LS II AD system (*Lie Shou,* meaning 'Hunter') with mixed missile armament of two SD-10/PL-12 and two PL-9C SAMs. The system again is mounted on a heavy mobility vehicle with a search radar, electro optical system and a laser range finder. Other point defence systems with the Chinese PLA are the FLV-1/FLG-1/FL 2000 wheeled air defence system with QW1A lightweight SAMs, Yi Tian WZ551 wheeled system with short range SAMs (TY90 variety) of a range of upto 6 km and there are shoulder fired SAMs including the QW2 and FN 16. Thus, the Chinese have based their point defence based on mobile components made out of radar controlled guns, very short ranged and short ranged SAMs. The quantities are thought to be adequate but the efficacy needs verification.

Short and Medium Range Area Air Defence

The next tier in air defence is short range and depending on how the nomenclature with respect to range is considered, some may even classify this in the category of medium range air defence. The 'short' is generally in the range of 20 to 30 km upto a height of 3-4 km while medium range extends upto 50 km. There could be various versions of these with high mobility versions mounted on high mobility vehicles like the Tatra, Tata or Ashok Leyland 8x8 vehicles or even mounted on tracked chassis.

Indigenously developed by DRDO, the Akash, is the most modern version of this

The MBDA Aspide 2000

Rafael's Spyder system

missile system with the Indian Army and Air Force. These are a complex combination of radars which carry out electronic scanning and provide information (air situation picture) to the next level of radars which are the tracking radars. These continue to track the targets assigned and guide the missile from their launchers to destroy the targets. For short range, these are are Tor M2K (successor of the versatile OSA-AK) and Pantsir system (without gun version) of Russia, MBDA–manufactured SPADA 2000/ASPIDE 2000 missile system which is a ground based missile system capable of operating in dense ECM environment to provide all weather area defence against combat aircraft and incoming missiles. Another important system from Israel is the remodeled air–to–air missile Derby and Python by Rafael, which makes a combination of these missiles into SPYDER (Surface-to-air PYthon and DERby), an advanced ground based anti-aircraft missile system that uses surface-to-air versions of the Python-5 and Derby missiles.

The Swedish company Saab is an important player in this segment with their BAMSE missile system and Giraffe surveillance radar. The Norwegian Advanced Surface-to-Air Missile System (NASAMS) of Raytheon is a highly adaptable mid-range solution for operational air defence requirement. This provides a state-of-the-art defence system to quickly identify, engage and destroy enemy aircraft, UAVs or cruise missiles.

Two missiles are in the medium range variety: the Russian Buk, developed as a successor to the Kvadrat and Kub missiles, and the Israeli Barak 1 and Barak 8, some of the most modern MRSAMs. The Barak is mounted on mobile vehicles and is vertically launched with active seeker missiles. These allow for actual fire and forget capability with multiple engagement capability. Such systems are generally deployed in a manner that an area is provided with ground based air defence, or also area air defence. Such area air defence assets have a variety of point air defence weapon systems in the designated geographical area depending upon importance of the assets.

In 1998, the China National Precision Machinery Import and Export Corporation (CNPMIEC) produced an improved HQ-7 with faster and longer-range missiles, with

an IR-tracking camera. This version with the export designation FM-90, is thought to be reverse engineered version of the Thomson-CSF Crotale missile, the missile system that Pakistan's air defence has recently procured. Apart from this, Pakistan's army air defence is not known to have any other short- or medium-range SAMs.

Until the early nineties, Chinese air defence was based on SA-2 SAMs and J-8 fighters. However, the Chinese have been reportedly moving ahead with area air defence steadily post breakup of the Soviet Union. Most of their SA-2s have been modernised and are in numerically significant numbers. China also has the Russian Tor M1 (SA-15) with indigenously produced derivatives like the HQ-9/HHQ-9/FD2000/FT2000. The FT 2000 is reportedly a derivative with missiles having anti-radiation seekers for engagement against AWACS aircraft and standoff jamming aircraft. The HQ-9 is likely to be using the Russian S-300PMU technology including vertical launch. It would probably fall under the MIM-104 Patriot category in terms of performance. The system has phased array radar mounted on a heavy mobility 8x8 vehicle and operates in the C-band with ranges up to 125 km. HHQ-9 is the naval version of this SAM. HQ-12/KS-1A of PLA compares with the US RIM-66 SM-1/SM-2 Standard Missiles in terms of performance. This system is to replace the now upgraded and hybridised HQ-2 and has a maximum range of 50 km and 27 km altitude. Very little is known about the HQ-16/SA-11, which is probably a Chinese-Russian joint development for area air defence.

China also has formidable long range anti-ballistic SAMs like Russian S-300 PMU-21 heavy mobility system to provide modern, multi layered integrated air defence systems.

Long Range Area Air Defence and Anti-Ballistic Shield

Air defence SAMs now also have to counter long range and standoff missile threats which have acquired serious proportions. The long range precision guided missiles fired from standoff ranges upto 100 km are beyond the capability of short or even medium range SAMs. Thus, air defence requirements now commence in taking on the threat at the longest ranges and against ballistic missiles which have trajectories across continents and pose serious threats. The counter systems include the S-400 (Triumf) of Russia, the extended range Barak, and the Patriot system. The S-400 has been in the news with its deployment in Syria and also with acceptance of necessity being granted for the Indian Air Force. The Russians deployed the first of the S-400 to protect Moscow in 2007.

The system was developed as follow on to the S-300 to improve capability against standoff attacks. The S-400 is highly flexible concerning engagement ranges, the system using multiple types of interceptors. The S-400 can engage very long range targets at 400 km, down to 40 km. The interceptor missiles need not be used on targets flying closer but to harass slow moving, high value targets (like AWACS, fuel tankers, transports, etc). The Russians find this approach of arming a single system with multiple interceptors most suitable. In comparison, Patriot is a long-range, high altitude, all-weather solution that has been rigorously tested by the US Army under real-world conditions. It can counter threats from tactical ballistic missiles, cruise missiles, drones and advanced aircraft.

Future Concepts

Air defence has to be primarily coordinated and carried out at the highest level and therefore, in India the overall responsibility of air defence remain with the Indian Air Force. Some countries, like Russia, have separate air defence commands and Pakistan has an Army Air Defence Command headquarters (HQ). Air defence is a complex business but there is a trend to simplify the systems. The complexity is owing to the fact that aerial threat has changed from fixed wing aircraft not only to complex ballistic missiles but also to drones which have varied ranges and speeds. One single system cannot cater for all these varied aerial threats. The complexity multiplies owing to the need of not only destroying or limiting the aerial threats but allowing 'friendly' aerial threat vehicles to utilise the same air space to destroy the enemy's assets. Therefore, the need for an integrated system which would have Command, Control, Communication, Computers and Intelligence (C4I) sub systems, detectors and sensors.

In terms of guns, the future would be of systems with unmanned and remotely-controlled turrets, having integrated ammunition feed. These will ensure faster reaction time and reduction in crew, multi-weapon platforms with guns and missiles on the same platform for improved kill capability. There is need for locating fire control systems on the weapon platform for shorter reaction time, provision of mobility with high mobility vehicles and high rate of fire with multi-barrel guns having independent breech blocks. In the area of ammunition, trends like advance hit efficiency, where muzzle velocity is calculated for each round and time to the target, is fed in the precision fuse resulting in the shell exploding at optimum range to create a sub projectile cloud.

Barak-8 from Israel

As for SAMs, the integrated air defence for point defence and area air defence in a grid fashion would be required if a system cannot alone meet various threats at various ranges. Even the S-400 system which has a variety of interceptors for variety of targets at various ranges has Pantsir system to provide close protection against unseen helicopters which could target the S-400 radars or missile launchers. A mobile grid, if resources are adequate, is one of the most effective ways to employ air defence resources, adding to

Saab's RBS 70 NG VSHORAD

flexibility and creating a theatre grid. Such a grid would then be able to also support manoeuvre forces and strategic assets. Multi-layered deployment to cater for vertical and horizontal aerial threats thus catering to air defence of high altitudes from low and very low altitudes is another approach, but deployment has to be in a layered and tiered manner, and time and area specific for best results. Israeli air defence with Arrow 3, Arrow 2, David's Sling and Iron Dome is an example for the upper and lower layers respectively. There is great need for all air defence command and control elements to be networked so that the gathering, fusion and dissemination of information to permit real or near-real time tasking, control, integration and co-ordination of maritime, land and air force AD capabilities can be realised.

The communications architecture should have sufficient capacity, security, jam-resistance and survivability to accommodate information exchange between all levels of command and control, including the capability to transmit operationally-essential information within a degraded communications environment. Voice and data links are primarily required for the task of communication. Tactical data links have also evolved to meet critical real-time and near real-time information exchange requirements, with particular significance for air defence operations.

Brig KK Iyer

Russian S-400 Triumf

In Action!
Rafael Air Defence Systems

Iron Dome launched

The growing spectre of aerial threats to civilian and military targets poses an immense challenge for air defence forces around the world. Efficient response is required against all types of airborne threats including aircraft, helicopters, short–to long-range missiles, and even unguided rockets.

Rafael's multi-layered, mixed weapons provide comprehensive protection for armed forces and population centres, with stout defences in the air and comprehensive protection on the ground.

Effective, quick and timely responses must deal with an entire spectrum of threats, even in the most demanding of saturated attacks. Systems need to be transportable by air, land, and sea to allow flexible deployment and protection. System solutions must also meet the requirements of each of the armed forces — army, air force and navy — and can be integrated, coordinated and operated by all three arms to provide comprehensive interoperability and interchangeability.

For some considerable time, Rafael's strategy has been on the development of precise, proportionate and discriminate systems that allow forces to carry out missions "effectively, efficiently and economically". One of Rafael's key products, which has received worldwide recognition and praise, is the Iron Dome, an active defence system against short-range missiles and rockets. The system is highly mobile, and thus easily deployable to protect critical infrastructure sites, civilian areas, and military installations and bases, another key element in increasing force survivability as well as maneuverability.

Iron Dome is the only dual mission counter rocket, artillery and mortar (C-RAM) and Very Short Range Air Defence (VSHORAD) system, now operational with the Israeli Air Force. Since its initial deployment, it has intercepted over 1500 rockets and mortars fired at Israel. The Iron Dome uses a unique interceptor with a special warhead that detonates targets in the air countering multiple threats simultaneously and efficiently.

David's Sling: Rafael Advanced Defence Systems, in partnership with Raytheon USA, has designed this affordable and lethal solution against long-range artillery rockets (LRAR), short-range ballistic missiles (SRBM), cruise missiles (CM) and traditional air defence threats. The system provides optimum protection for homeland assets as well as forward deployed forces. The David's Sling Weapon System consists of a Battle Management and Command Array, as well as an Interceptor Array. A Multi-Mission Radar is used for detection and tracking of threats. The Weapon Control System (WCS) is a battle management and weapon control system that enables optimal, real-time mission planning against a large number of simultaneous threats. The WCS is also the system's interface to senior command levels, Air Control Units, as well as to other sensors and defense systems. In December 2015 the fourth full system was successfully tested, for delivery to the Israeli Air Force later this year.

Spyder: This short and medium range air defence missile system is designed to engage and destroy a wide spectrum of threats, including attack aircraft bombers, cruise missiles, UAVs, UCAVs and stand-off weapons. The Spyder ADS Air Defence System ensures protection of high value assets as well as manoeuvring combat forces. The system is an all-weather, network-centric, self-propelled, multi-launch, quick-reaction ADS. Spyder incorporates Rafael's most advanced missiles : the i-Derby and i-Derby ER (100 km range) active radar Beyond Visual Range (BVR) missiles and the Python-5, a sophisticated dual band Imaging Infra Red (IIR) missile. Both missiles are equipped with a booster.

For the control operation of both air and missile defence missions, Rafael has developed the MIC^{4}AD Modular Integrated C^{4}I, which provides a total solution for multi-systems, multi-layer and multi-range air and missile defence threats. MIC^{4}AD's flexible resource management engine creates an optimiced solution to all threats at any level of command (national, regional or tactical).

Spyder-SR system

Saab's BAMSE SRSAM

"The system with unique capabilities"

The BAMSE SRSAM system is one of few such in the world today developed and optimised as a dedicated Ground-Based Air Defence (GBAD) missile system. It is an all-weather operational Automatic Command-to-Line-of-Sight (ACLOS) missile system with unjammable missile guidance, designed for flexible usage both for stand-alone operation as well as in a network with other sensors and weapon systems.

The BAMSE SRSAM system consists of a set of missile launchers and BAMSE Missile Control Centres (MCC), co-ordinated by Giraffe AMB multi-mission surveillance radar, acting both as radar sensor and C4I unit. A basic battery configuration including one Giraffe AMB and four BAMSE MCCs, provides ground coverage of more than 2,100 km^2 and an effective altitude coverage of up to 15,000 m against all types of aerial threats, from small, high velocity anti-radiation missiles to large, low-speed bomber aircraft.

The Giraffe AMB *(Agile Multi Beam)* automatically detects and tracks air targets out to an instrumented range of 120 km and is, through powerful built-in command and control functions, capable of not only designating targets to subordinate BAMSE MCCs, but also of acting as a Command Post in networks of other GBAD systems, such as the RBS 70 NG. The BAMSE SRSAM system is quickly coordinated from higher levels of command, to which the battery connects via the Giraffe AMB.

Through an extensive suite of ECCM features, the EW threat is countered in an effective way. The system is also totally unaffected by countermeasures such as flares, chaff or other countermeasures.

"The BAMSE SRSAM system is a high precision system which can engage and defeat cruise missiles and small targets like UAVs even at long ranges. Furthermore the BAMSE SRSAM system has a very short reaction time, just a matter of seconds from first detection in the Giraffe AMB until the missile is in the air", explained Jan Widerström, Country Head and Chairman, Saab India Technologies Pvt Ltd.

Modern fighter aircraft and helicopters are usually equipped with missile warning systems and corresponding countermeasures. As soon as the aircraft gets a warning that it is engaged by a missile it will start to manouvere, use flares or other countermeasures. The BAMSE missile counters highly manoeuvrable jinking targets. This is a clear advantage compared to homing missiles which can make only a few sharp manoeuvres before losing performance. While a homing missile has to manoeuvere 3-4 times as much as the target, the BAMSE missile never does more than the target does due to its ACLOS guidance principle. A target can therefore outmanoeuvre a homing missile – but never the BAMSE missile !

In February 2016, Saab announced plans for a joint venture company in India with Kalyani Strategic Systems Ltd (KSSL), which is the defence arm of the Kalyani Group. The joint venture will handle the main part of production and delivery of these air defence systems to the Indian operator. "The production in India will comprise of subsystems and systems for SRSAM and VSHORAD with the aim to transfer production as well as development knowledge to India," said a Saab spokesperson.

IOC for F-35A Lightning II

The F-35A has been declared 'combat ready' by the US Air Force, with Gen 'Hawk' Carlisle, Chief of Air Combat Command declaring on 2 August that the F-35A Lightning II had achieved initial operational capability (IOC) with the 388th Fighter Wing's 34th Fighter Squadron at Hill Air Force Base, Utah. "The F-35A will be the most dominant aircraft in our inventory, because it can go where our legacy types cannot and provide the capabilities our commanders need on the battlefield," stated Gen Carlisle. Secretary of the Air Force Deborah Lee James also said, "This important milestone for our fighter force ensures the US, along with our allies and international partners, remains prepared to deter, deny and defeat the full spectrum of growing threats around the globe."

The 34th and 466th FS at Hill AFB, Utah have completed all requirements to achieve IOC following the submission of documentation for consideration on 27 July. The 34th had 12 F-35As equipped with the modification necessary for it to achieve IOC, with 21 combat-ready active-duty and reserve pilots assigned to the squadron. At present, the 388th FW has enough deployable aircraft, personnel equipment and spares to support a six-aircraft deployment. The 388th and the 419th Fighter wing, its Air Force Reserve Command Associate, had been conducting training sorties at the Utah Test and Training Range and carried out a simulated combat deployment to Mountain Home AFB, Idaho in June.

Boeing and Saab reveal their T-X proposal

On 13 September, Boeing and its partner Saab revealed their *de novo* future jet trainer designed to meet the US Air Force's T-X requirement. The Boeing/Saab T-X is an all-new aircraft designed specifically for the US Air Force training mission to replace the current T-38, "and takes advantage of the latest technologies, tools and manufacturing techniques… an advanced aircraft designed to evolve as technologies, missions and training needs change. The design is more affordable and flexible than older, existing aircraft."

The single GE F404-engined Boeing/Saab T-X aircraft has twin tails, tandem seating and an advanced cockpit with embedded training. The system also offers state-of-the-art ground-based training and a maintenance-friendly design for long-term supportability. Initial operating capability is planned for 2024.

JF-17s for Sri Lanka?

As reported earlier, the Sri Lankan Air Force (SLAF) has evaluated the Sino-Pakistani JF-17 Thunder and an initial order for 8-12 of this multirole fighter is imminent, according to sources in Colombo. The visit of Pakistan Air Force CAS, Air Chief Marshal Sohail Aman to Sri Lanka, in end-August 2016, coincided with the approval by the Sri Lankan Cabinet to purchase new fighters for the Sri Lankan Air Force (SLAF) on a government to government basis. This has given rise to speculation that the Sri Lanka may be going in for purchasing the China developed, and Pakistan manufactured JF-17 light combat fighter. Pakistan has been attempting to export the fighter aircraft in the neighbourhood, with Sri Lanka and Myanmar being the primary customers targeted for the same.

The SLAF had received "extensive support from the Pakistan Air Force during the long period of civil war against the Liberation of Tamil Tigers Eelam (LTTE)" apart from extensive military assistance from some countries including China, Pakistan, Russia, Ukraine and Israel. The Pakistan Air Chief is reported to also have offered extensive training and professional support to the Sri Lankan Air Force during his interaction in Sri Lanka.

Flight testing of T-X-related T-50A

Lockheed Martin and Korea Aerospace Industries have completed initial test flights of its second T-50A configured aircraft in Sacheon, South Korea. The T-50A is being offered for the company's US Air Force's Advanced Pilot Training (APT) competition and builds on the proven heritage of the T-50 with more than 100 T-50s built. The T-50A was developed jointly by Lockheed Martin and Korea Aerospace Industries.

Ospreys for Japan

The US Naval Air Systems Command has awarded Bell-Boeing Joint Project Office a contract for long lead production materials and the manufacture and delivery of four MV-22 Osprey tiltrotor aircraft for the Government of Japan. It also incorporates an engineering change proposal for the standby flight display, work expected to be completed in May 2020. An initial five Ospreys for Japan had been placed with Bell-Boeing on 14 July 2015, marking the first export order for the type.

Meanwhile, Northrop Grumman was awarded a Foreign Military Sales contract on 28 July for one E-2D Advanced Hawkeye configured for Japan. This is the second E-2D to be ordered for the Japan Air Self-Defence Force (JASDF) service, the JASDF planning to procure four E-2Ds for AEW&C situational awareness of air and naval activity in the Pacific region, augmenting its existing fleet of 13 E-2C Hawkeyes.

British Military Flying Training System

The company Ascent, which is providing the military flying training system for the RAF is to have a fleet of 23 Grob G120TP Prefects (below, top), ten T-6Cs and five Phenom 100s

According to AVM Andy Parker, AOC 22 Group, "The last of the old aircraft (Grob 109s, Tucano T1s and King Air 350s) will be phased out of service in October 2019 and the transition is well planned to take place during 2017-18. Meanwhile, the Hawk T1 advanced jet trainer will be phased out from the Royal Navy's 736 NAS at RNAS Culdrose in 2020, the RAF's 100 Squadron in 2027 and the Red Arrows in 2030. A future AJT has yet to be identified.

100th Grob G120TP

Sales of Grob Aerospace's G120TP trainer have been buoyant and the 100th aircraft is currently undergoing final assembly, while an order backlog of around 90 will maintain production until the end of 2018. The company is building 5-6 G120TPs every month, but has the capability to double production if required. The German manufacturer was awarded a contract earlier this year to produce ten aircraft for the Royal Jordanian Air Force in the elementary pilot training role. The deal also includes a computer-based training system and a G120TP flight training device. Another order earlier

this year is for 23 aircraft to be operated by Affinity Flying Traning Services as a part of the UK's Military Flying Training System (see separately). The type will be known as the Prefect in honour of the single-engine Avro biplane trainer used by RAF pilots before and during the Second World War.

24 Texan IIs for Argentina

Approval has been given for a Foreign Military Sale to Argentina of 24 Beechcraft T-6C+ Texan II trainer aircraft, the deal estimated to be worth $300 million. The Government of Argentina has requested spare engines, initial spares, support and communications equipment, initial maintenance and pilot training, follow-on training, alternative mission equipment, unclassified minor modifications and engineering change proposals, a ground-based training system and an operational flight trainer. "The *Fuerza Aérea Argentina* FAA, will use the enhanced capability to redevelop a professional pilot corps and as a deterrent to illicit activity."

Senegal orders KAI KT-1s

Korea Aerospace Industries (KAI) is to supply four KT-1 Woong-Bee turboprop trainers to the *Armée de l'Air Sénégalaise* (Senegales Air Force). The contract was signed on 15 July following talks during September 2015 in Seoul between South Korean President Park Geun Hye and her Senegalese counterpart. The KT-1 has already secured orders from Indonesia (17), Peru (20) and Turkey (40), in addition to the ROKAF (85 KT-1S and 20 KA-1 light attack variants.) The type also competed for the Indian Air Force's basic trainer competition but lost out to the PC-7 Mk2 on prices, which were strongly disputed by KAI.

Jordan replaces PC-9M by PC-21s

Jordan has revised a contract with Pilatus, replacing its order for nine PC-9Ms and ordering eight PC-21s. The eight Royal Jordanian Air Force (RJAF) PC-21s will have Esterline CMC cockpit displays, dual flight management systems (FMS) and GPS landing system sensors as well as a head-up display (HUD) sub-system. While various air forces earlier flying the Pilatus PC-7 are supplanting the type with later versions of this turboprop trainer, the Indian Air Force instead, selected this earlier variant for its basic flying training task in 2013.

Australian PC-21 test flight

First of the 49 Pilatus PC-21 aircraft destined for the Australian Defence Force has successfully made its initial production test flight at Stans in Switzerland, only seven months after contract signature. Under a contract signed in December 2015 aimed at harmonising Australian Defence Force flight training across all three services – Army, Navy and Air Force – Pilatus will deliver a total of 49 PC-21 which will operate from four Royal Australian Air Force bases. Under the AIR 5428 project the PC-21 aircraft will replace both the aging PC-9 fleet, which has been in service since 1988, and also the indigenous CT-4 aircraft currently used for basic training.

SPEAR 3 missile launch trials

An RAF Eurofighter Typhoon recently fired an MBDA SPEAR 3 air-to-surface precision strike weapon for the first time in trials conducted from BAE Systems' site in Warton, Lancashire. MBDA Missile Systems has been awarded a $600 million SPEAR 3 development contract by the UK MoD, the weapon being developed

primarily for the UK's F-35B Lightning II programme, although it will also be integrated on to the RAF's Typhoons. Meanwhile, flight trials of the E-Scan radar (Captor-E) have begun on the Typhoon following successful completion of ground tests using an RAF Eurofighter test aircraft, clearing the path towards full integration of the radar.

Flight tests have begun at BAE Systems' site in Warton, Lancashire, where IPAS undertook its first sortie with the radar installed in early July, when it was airborne for around one hour. A second test aircraft based in Germany is set to join the integration programme. The trials are designed to ensure the radar and weapons system reach the required capability in time for first deliveries to the Kuwait Air Force (KAF), which became the Typhoon's eighth customer earlier this year. The E-Scan radar and weapons system capability will be incrementally enhanced over the next three years for the required capability (P3E Standard) to be available for the first deliveries to the KAF.

Dassault upgrade of Mirage 2000Ds

The French defence procurement agency DGA has given Dassault Aviation responsibility for upgrading 55 Mirage 2000D aircraft in service with the French Air Force. The Mirage 2000D entered service in 1993 and is tested essentially for ground attack, the modifications include those on the weapon system, involving Mica missiles.

Pegasus KC-46A production 'Go Ahead'

The KC-46A Pegasus has received a Milestone C approval to enter low-rate initial production (LRIP), the USAF to issue a contract to Boeing for the first two lots of 19 tankers by mid-September. The USAF carried out the successful refueling of an

A-10C on 15 July, marking its final flight test for the Pegasus to be approved to enter production. During flight tests, the KC-46A transferred 680kg of fuel to the A-10, the successful completion of which has allowed Pentagon to make a formal Milestone C decision that will allow Boeing to begin production of seven Lot 1 and 12 Lot 2 KC-46A aircraft. In addition to refueling the A-10C, C-17A and F-16 via the boom, the KC-46A has already transferred fuel to the F/A-18 and AV-88 via its centerline and wing drogue system during flight tests. Under the latest plans, Boeing will begin delivering production KC-46As in August 2017.

First Typhoon Brimstone Trials

An RAF Eurofighter Typhoon completed a first series of flight trials with the MBDA Brimstone precision strike air-to-surface missile, ahead of firing trials as part of a programme to integrate the weapon onto the aircraft. Conducted from the BAE Systems site in Warton, Lancashire, the trials tested successful airborne communication between the aircraft and missile and gathered flight data to ensure a mature product is ready for initial firing trials due in the first quarter of 2017. Meanwhile, integration of the MBDA Storm Shadow missile is continuing, building on the ground trials of the weapon and two successful releases of Storm Shadow from an Italian Typhoon in 2015. More firing trials have been completed with MBDA's Meteor beyond-visual-range air-to-air missile, at the UK's Hebrides range.

Egypt orders 7 SH-2Gs

The Egyptian Air Force has acquired seven additional SH-2G Super Seasprites as *Excess Defence Articles* (EDAs) from US Naval Air Systems Command (NAVAIR). These will bring the EAF's fleet to 17, the depot being established at the EAF's Helwan Aviation Depot Workshop, near Cairo. The EAF currently operates ten SH-2G€ Super Seasprites.

The Air War in Syria

The picture shows Russian AF Tu-22M3s in Iran supported by two Il-76MD transports, the bombers landed at the Iranian air base of TFB.3 on the evening of 15 August.

Su-22M4s for Iran

Restoration of ex-Iraqi Air Force Su-22s for Iran's Islamic Revolutionary Guard Corps Air and Space Force (IRGCASF) is continuing. In June 2015, the IRGCASF received its first two Su-22s (a Su-22UM and a Su-22UM3) after restoration by Pars Aviation Services Company at Mehrabad (Teheran). On 6 June, the IRGCASF's Su-22 Squadron was officially established at Seyyed al-Shohada air base in Shiraz (*see Vayu Issue III/2016*).

The Iraqi Air Force, meanwhile, is re-equipping with US fighters and in early August, another batch of four Lockheed Martin F-16C/Ds flew to Balad Air Base, Iraq, increasing the number of F-16s in service with Iraq's 9th Fighter Squadron to 10.

PAF F-16s at 'Red Flag'

On the heels of Indian Air force participation at *Red Flag – Alaska* in April 2016 (*see Vayu IV/2016*), the Pakistan Air Force took part in the subsequent exercise *Red Flag 16-4*. Six F-16C/D Block 52s from No. 5 Squadron first deployed to Nellis AFB, Nevada in July for a *Green Flag* exercise and then, the following *Red Flag*. In related news, it was reported that the eighth Israeli Air Force F-16 I (*Sufa*) fighters also took part in *Red Flag* exercises this year, jointly with several other air arms including those for the UAE and Pakistan. Although the head of Israeli AF Training Directorate did not discuss the identity of other air forces at *Red Flag*, an Israeli spokesperson said "the IDF trains regularly to maintain operational competence and be prepared for any potential challenge." Some 50 combat aircraft from five air forces participated in the *Red Flag* Exercise, alongwith helicopters, AEW&C aircraft, plus intelligence and special forces units.

Final MH-60R Seahawk delivered to RAN

Lockheed Martin, together with the US Navy, has delivered the 24th, and final, MH-60R Seahawk helicopter to the Royal Australian Navy (RAN) at Lockheed Martin's purpose-built logistics and maintenance facility in Nowra which will house and maintain the new fleet. Based in Nowra on the New South Wales south coast, the 8,300 square metre facility will house Sikorsky's Australia-based, Helitech, Lockheed Martin and the US Navy.

In addition to the MH-60R helicopter's primary mission areas of anti-submarine and anti-surface warfare, it also has the capability for secondary missions including search and rescue, vertical replenishment, naval surface fire support, logistics support, personnel transport, medical evacuation, and VHF/UHF/link communication relay. The new MH-60R helicopters are currently replacing the RAN's existing fleet of S-70B-2 Seahawk helicopters.

J-20 stealth fighter in Tibet

An image of China's first stealth fighter, the J-20, reportedly at the Daocheng Yading airbase in Tibetan Autonomous Region has been tweeted. The J-20 is seen covered in tarpaulin at the Tibetan airport at an altitude of more than 14,000 feet. Deployment of the J-20 could be part of high-altitude trials. The Chengdu J-20 has gone into low-rate production in January 2016. The type flew for the first time in January 2011, while new variants have appeared with modified design-features.

Pakistan 'aid' to China

In what is obviously a public relations exercise, China has accepted aid from Pakistan in the form of a military transport aircraft transporting rice for flood stricken areas of central China's Hubei province. The PAF aircraft flew in 22 tons of rice to Wuhan airport as a gesture as it is a beneficiary of a $46 billion project sanctioned by Chinese president Xi Jinping for building an economic corridor passing through the country and ending in Gwadar port on the Arabian Sea.

"Warning" against BrahMos deployment

Shortly after the Indian government cleared deployment of the BrahMos cruise missile in Arunachal Pradesh, China has warned that such a move would have "a negative influence" on stability along the border and added that "deploying BrahMos missiles is bound to increase competitiveness and confrontation in Sino-Indian relations and bring a negative influence to stability of the region." India's cabinet committee on security, chaired by Prime Minister Narendra Modi, had earlier cleared the raising of a new unit to be equipped with a version of the BrahMos developed for mountain warfare at a cost of more than Rs 4,300 crore. The new regiment for the northeast will have some 100 missiles, five mobile autonomous launchers on heavy-duty trucks and a mobile command post.

The missile's "penetration capabilities" poses a threat to China's border regions, according to an expert from the PLA Navy's engineering university. However, it added that the BrahMos missile's range of 290 km "cannot threaten China's deep zones". The Indian Army has so far raised three regiments equipped with earlier versions of the BrahMos, which was jointly developed by India and Russia.

Pentagon blocks $300 mn "reimbursement" funds to Pakistan

The US Pentagon has blocked military aid worth $ 300 million to Pakistan after Defence Secretary Ashton Carter declined to give a certification to the Congress that Pakistan was taking sufficient action against the infamous Haqqani network. The move is being seen as a "potential blow" to US-Pak ties.

In the absence of Congressional certification, the Pentagon has blocked such disbursement under 'Coalition Support Fund', which is essentially reimbursement money for the expenses made by Pakistan Army in support of US operations in Afghanistan. Pakistan had been authorised $ 900 million in fiscal 2016 CSF, of which, $ 350 million is subject to a Secretary of Defence certification that Pakistan has taken sufficient action against the Haqqani network, he said.

However, he continued being "encouraged by Pakistan's operations in North Waziristan and elsewhere in the FATA. Pakistan's efforts have reduced the ability of some militant groups to use North Waziristan and the FATA as a safe haven for terrorism. However, the Afghan Taliban and the Haqqani network continue to operate in other locations in Pakistan," stated a Pentagon spokesperson.

Massive Japanese defence budget

Japan's defence ministry have requested an increased budget to $ 35 billion amid concerns over China's construction of artificial bases in the South China Sea and claims to Senkaku and Diaoyu islands in the East China Sea.

Japan has made annual cuts to its defence budget for a decade up to 2013 and increases since then reflect its growing anxiety about China's expanding naval reach. This is also in line with Japan's more assertive defence policy under Prime Minister Shinzo Abe, as he seeks to check Chinese influence and expand the scope of his country's military. The budget request, an increase of 2.2% on last year, demonstrates a shift in Japan's security emphasis from its northern maritime border with Russia to its long and porous

A Global Hawk surveillance drone is displayed outside its hangar at Misawa air base in northern Japan (photo: Eric Talmadge/AP)

southern reaches. In contrast to previous investment in tanks and heavy artillery, building a more flexible and mobile force – including its own version of the US Marine Corps – that would be able to quickly defend territory against an invading enemy.

Japan is building a military radar station on Yonaguni island, just 94 miles south of the islands. The Japanese ministry's shopping list includes amphibious assault vehicles, Osprey tilt-rotor aircraft, F-35 stealth fighters and an advanced Aegis radar-equipped destroyer. It also wants to acquire Global Hawk drones and surveillance helicopters to defend far-flung islands along an 870-mile stretch of ocean between the Japanese mainland and waters off Taiwan, besides seeking extra cash to build new military bases and expand existing ones on some of the islands, equipping them with state-of-the-art radar and missile batteries.

Interestingly, and most indicative of the evolving global 'great game', the Japanese have officially suggested that they could consider partnering India and developing the Chabahar port project in Iran. Earlier this year, the Government of India, Iran and Afghanistan had signed a tripartite agreement to develop the Chabahar port into a tourist hub to bypass Pakistan and in parallel to China's development of Gwadar port in Pakistan's Baluchistan. Strategic affairs observers have opined that an India-Japan partnership in Chabahar will help counter the strategic significance of the expanding Chinese footprint in Pakistan, particularly at Gwadar port.

First Spanish Air Force A400M

The first Airbus A400M new generation airlifter ordered by the Spanish Air Force has made its maiden flight, marking a key milestone towards its delivery. This was on 5 September at Seville, Spain. The aircraft is scheduled to be delivered shortly.

Airbus A330MRTT for Netherlands

The Netherlands Ministry of Defence has signed a MoU with Luxembourg to proceed with the acquisition of a pooled fleet of Airbus A330 Multi Role Tanker Transport (A330 MRTT) aircraft. Signing of a contract will pave the way for delivery of two aircraft with options for up to six more when, as expected, other nations join the grouping. The contract also covers two years of initial support.

Hawk sustainment contract in Australia

BAE Systems Australia has secured a two-year contract, worth approximately $200 million, to sustain the Royal Australian Air Force (RAAF) Hawk Mk127 lead-in fighter fleet at Williamtown and Pearce until at least 2020, with further potential extensions available until 2026. The role includes all deeper-level and operational maintenance for the 33 aircraft.

As BAE Systems Australia Aerospace Director Steve Drury stated, "It will ensure the Hawk fleet continues to effectively prepare the country's combat aircrew for fast jet aircraft, including the F-35 Joint Strike Fighter when it arrives. Since 2013, BAE Systems' support of the fleet has achieved all contract key performance indicators, including aircraft availability and overall fleet management. Working alongside the RAAF, we have ensured aircraft are available for training when needed, and have continued to deliver significant savings in sustainment."

50th KC-130J for US Marines

The US Marine Corps has taken delivery of its 50th KC-130J Super Hercules aerial refueler, assigned to Marine Corps Air Station Miramar, California. The KC-130J aerial refueling tanker is the latest in a long lineage of combat proven KC-130 Hercules aerial refueler technologies "while taking full advantage of tremendous technological and performance improvements inherent in the basic C-130J aircraft."

Pakistan to acquire eight attack submarines from China

According to authoritative reports, the Pakistan Navy will acquire eight modified diesel-electric attack submarines from China. In April 2016, a senior Pakistan Navy official had announced that Karachi Shipyard and Engineering Works (KSEW) had

contracted to build four of the eight submarines, to be fitted with air-independent propulsion (AIP) systems. Although it has not officially been confirmed what type of submarines will be supplied to the Pakistan Navy by the China Shipbuilding Trading Company (CSTC), analysts speculate that the new submarines will be lighter export versions of the Chinese Navy's Type 039 and Type 041 *Yuan*-class conventional attack submarines. The first four submarines are expected to be delivered by the end of 2023 while the other four will be built in Karachi by 2028.

Pakistan's submarine fleet presently comprises two French-origin Agosta70 and three Agosta 90Bs and three MG110 miniature submarines (SSI). One of the Agosta 90Bs, *Hamza* (*Khalid*-class), was indigenously constructed and commissioned in 2008 while another was partially completed indigenously and the third was built in France.

Pakistan Navy inducts ATR-42, UAS-42

The Pakistan Navy has inducted its third ATR aircraft as also Scan Eagle Unmanned Aerial Systems during induction ceremony at PNS *Mehran* on 1 September 2016. Chief of Naval Staff Admiral Mohammad Zakaullah said that "the Pakistan Navy Air Arm had come a long way since its inception in the early 1970s. The induction of ATR aircraft is part of the PN Aviation Vision 2030."

CNS said that induction of the Scan Eagle Unmanned Aerial System was "yet another major transformation in terms of acquisition of new capabilities. It would start a new era in the PN's operational capability by enhancing its intelligence, surveillance and reconnaissance capabilities."

50th Anniversary of TPE331 engines

2016 marked the 50th anniversary of Honeywell's TPE331 turboprop engine, which powers multiple types of aircraft around the world. Designed for the military, the engine was developed for multiple applications across military and general aviation and "is the most cost-effective and powerful engine in its class with the lowest cost of ownership." Its simple single-shaft design provides an instant throttle response and best-in-class hot-and-high performance. Since the first commercial version of the engine received its type certification from the Federal Aviation Administration in 1965, the series now includes 18 models and 106 configurations. More than 13,500 TPE331 engines have been delivered to date, logging more than 122 million hours of flight time. The TPE 331-5 powers HAL-built Dornier 228s, (see above) near 150 of which have been built in India for various operators and for export.

Another HAL Dornier 228 for Mauritius

A third HAL-built Dornier 228 has been delivered to the Mauritius National Coast Guard, formally commissioned into service on 14 July 2016, under a contract signed on 27 November 2014. The aircraft joins two other HAL-Dornier 228s already in service with the National Coast Guard's Maritime Air Squadron, based at Port Louis-Sir Seewoosagur Ramgoolam International Airport. The National Coast Guard is a specialised branch of the Mauritius Police Force, under the control of the Commissioner of Police.

Y-12Es and Dauphins for Djibouti

Meanwhile, two Chinese-origin Harbin Y-12E light transport aircraft, have *entered Force Aérienne Djiboutienne* (FAD – Djibouti Air Force) service, formally handed over at the FAD's main base at Djibouti-Ambouli International Airport on 13 July. It was also revealed that the FAD is operating Dauphin helicopters, a type not previously in the FAD inventory. Four recently acquired Dauphins were on static display at the Y-12 handover reportedly acquired with assistance from Saudi Arabia.

C 295Ms and Wing Loong UAV for Kazakhstan

A fifth C295M has been delivered to the Kazakhstan Air and Air Defence Force, the additional transport aircraft arriving at Almaty-Burunday Air Base after being ferried from the factory at Seville-San Pablo Airport, Spain. Kazakhstan had initially ordered two C295Ms with options on six more on 1 March 2012, with first two aircraft delivered in December 2012. The Kazakh MoD has stated that the type "has proved reliable in service and it plans to take delivery of all eight aircraft."

The first public viewing of the Kazakhstan Air Defence Force's Chengdu Wing Loong unmanned combat air vehicle was at the KADEX 2016 arms and military equipment exhibition, held at Astana from 2-5 June (*see Vayu IV/2016*). This was the first time a Kazakh UAV had been displayed to the public, the first two of the type having been delivered to the country in late March.

Thai Air Force Sukhoi SuperJets

Two Sukhoi SuperJet 100-95LR aircraft in VIP configuration were handed over to the Royal Thai Air Force (RTAF) during an official ceremony on 15 July, the first aircraft was then flown to Bangkok on 28 July and were scheduled to enter service within the next two months for VIP transportation. Each aircraft is configured with a four-passenger VIP area, six-passenger business class section and a 50-passenger standard seating cabin. The first aircraft made its maiden flight with test registration on 23 October 2015 at Komsomolsk-on-Amur/Dzyemgi, where it was built on the Komsomolsk-on-Amur Aircraft Production Association (KnAAPO) production line.

MRJ's sales successes

Japan's Mitsubishi Regional Jet (MRJ) has secured its first commitment from a European customer when Swedish lessor Rockton signed a letter of intent for ten MRJ90s plus options for ten more, with first aircraft scheduled to be delivered to Rockton from 2020. Mitsubishi has so far secured firm orders and commitments for 447 (with 223 as firm) MRJs from six customers including US counterpart Aerolease Aviation, which has signed a letter of intent for ten MRJ90s.

The first two prototype MRJs are now flying, with aircraft numbers three and four undergoing function testing ahead of their first flights; the fifth and final one is structurally complete and being fitted out with test instrumentation. Mitsubishi is currently working to prepare four aircraft for the long delivery flight to its Moses Lake Flight Test Centre in Washington State, where most of the MRJ's testing and certification work is being conducted. In Japan, the MRJ's new final assembly hangar has been completed and fitted out, and the first production aircraft on jigs in July. The site can accommodate 12 MRJs at a time and the company is working towards an initial production rate of ten jets per month.

Turkey orders TRJ 328s

The Istanbul Chamber of Commerce has signed a letter of intent for ten TRJet TRJ328 regional jets with a possible requirement of up to 50 aircraft. This was indicated by the Turkish Ministry of Transport, Maritime Affairs 7 Communications and Sierra Nevada Corporation launching the Turkish Regional Aircraft Project.

The TRJ 328 is essentially the Fairchild Dornier 328, developed and produced both in turboprop and turbofan versions, built at the Oberpfaffenhofen facility near Munich till 2002, when the company went into receivership. With over 200 of the type in service worldwide, the 328 was a natural complement to the 20-seater Dornier 228, which continues in production by HAL in India. Although, this government-owned entity did not take advantage of its original contract, which included the 328, private Indian sector companies were on the cusp of assuming the programme some years back but did not pursue the opportunity, which has now been taken over by Turkey.

Nile Air flights to UAE

The Egyptian carrier Nile Air has begun flights to the United Arab Emirates with services between Cairo International Airport and Al Ain with Airbus A320s. Nile Air's CEO has said the new service offers a convenient travel option between both cities for business travellers and tourists visiting Egypt plus the estimated 100,000 Egyptian nationals residing in the city of Al-Ain and its surrounding region who wish to travel home.

Naft Airlines

Iranian carrier Naft Airlines is to acquire ten Airbus 320s as part of its fleet renewal programme. Managing Director Rezal Niyarak said, "The aircraft would enable Naft to expand operations and improve its on-time performance." Formerly known as Iranian Air Transport, the carrier operates four Fokker 100s and six Fokker 50s on domestic and regional services from its Ahwaz hub to Bandar Abbas, Dubai, Isfahan, Kish, Mashhad, Nowshahr, Rasht, Tehran Mehrabad and Yazd.

Air Canada orders 45 Bombardier C Series

As long expected, Air Canada has placed firm orders for 45 Bombardier CS300 airliners with options for an additional 30. CEO Alain Bellemere said, "I am pleased to officially welcome Air Canada to our CS300 family of operators as one of our largest customers and early adopters. As an innovative operator, admired for successfully reinventing itself and, like Bombardier, based in Québec, Air Canada and the C Series aircraft are a perfect match. This order is a major statement of support for Canada's aerospace industry and will help support thousands of C Series-related jobs. It also serves as an important catalyst for renewed interest and subsequent orders."

PIA leases Sri Lankan A330s

Pakistan International Airlines has confirmed its negotiations with Sri Lankan Airlines concerning the wet lease of four Airbus A330-300s. The Pakistani national carrier has been looking for additional widebody airliners and Sri Lankan Airlines has proposed leasing four of its seven Airbus A330-300s. Pakistan International Airlines' new premier service will debut on the Islamabad-Heathrow route, and will feature fully lie-flat beds in the premier cabins. A statement on PIA's website said: "With new aircraft, more

professional crew and improved service standards, the new service aims at providing an altogether different experience to passengers. This service will go a long way in helping PIA regain its market share both domestically as well as internationally."

Airbus A330 for Tibet Airlines

Tibet Airlines has taken delivery of its first Airbus A330. The 242-tonne maximum take-off weight (MTOW) variant will be operated from Lhasa Airport at an altitude of 11,485 ft (3,500m) above sea level and the increased MTOW provides the airline with the performance abilities to operate in this demanding environment. As Bal Welsan, President of Tibet Airlines stated, "We are extremely excited to receive our first widebody airliner, an enhanced A330 from Airbus and are very confident of its high altitude performance. The A330 Family will become our core widebody to be deployed on our new international routes owing to its flexibility, comfort and efficiency. With the A330, we are looking forward to more passengers from all over the world flying with Tibet Airlines and visiting Tibet." The A330 will initially be employed on flights from Lhasa to Chengdu and Beijing.

China rolls out AVIC AG600 Amphibian

In a major development, China's AVIC AG600 large amphibious aircraft prototype was formally rolled out at Zhuhai on 13 July 2016. The aircraft, which is currently the largest amphibious aircraft in the world, is powered by four turboprop engines, each driving six-blade propellers. The aircraft has a maximum take-off weight of 53.5 tonnes, a range of more than 3,100 miles (5,000km) and a wingspan of 130ft (40m). Developed by the China Aviation Industry General Aircraft Company CAIGA, its construction was undertaken by a number of AVIC subsidiaries, including the Hanhong Aircraft Company, which manufactured the centre and rear fuselage.

The AG600 is designed for several roles, including aerial firefighting, for which it can carry 12 tonnes of water. For maritime search and rescue, it will be able to accommodate 50 personss, while it is also suitable for maritime patrol, passenger or freight transport. AVIC has 17 orders for the AG600 from domestic users and expects to deliver upto 60 over 15 years. The type would seem to be a suitable successor to the smaller Harbin SH-5, just four production examples of which were built for the Chinese People's Liberation Army Naval Air Force (PLANAF).

Japan's future fighters

Boeing and Lockheed Martin have been identified as possible contendors for design and development of Japan's future F-3 fighters. According to the Japan Air Self-Defence Force, either US firm could be involved in the project with costs estimated at around $ 20 billion. In June 2016, the Japan Ministry of Defence issued a request for information (RFI) from various international companies and a final decision on how to proceed is expected next year commencing April 2018. Japan has however yet to formally decide on development of an indigenous fighter to replace the current F-2, but is seeking joint development opportunities with foreign manufacturers.

Canada to re-evaluate fighters

Five companies have reportedly submitted responses to the Canadian government's request for information (RFI) for a new fighter these being the Boeing F/A-18E/F Super Hornet, Lockheed Martin F-35A, Eurofighter Typhoon, Dassault Rafale and Saab JAS 39E Gripen. The F-35 is being considered despite the new Canadian government having "pledged" not to procure this type. However, there are reports that for cost reasons, Canada may indefinitely extend the formal bidding process and initiate a procurement for 20-30 fighters as an interim measure.

A400M demonstrates sand runway capability

Capability of the A400M new generation airlifter has been demonstrated to operate on a sandy runway, which is the last of three unprepared types of surface on which it will be certified.

The tests using the development aircraft MSN2 took place in August on a specially constructed airstrip at Woodbridge, UK and included operations at increasingly higher weights. The A400M demonstrated excellent performance in taxying manoeuvres, such as U-turns, and during take-off and landing on the 1,600m (5,250ft) strip. These tests followed earlier successful results on the gravel surface at Ablitas in Spain and a grass runway at Écury in France.

PT6A for Grob G520NG

Grob Aircraft has selected the Pratt & Whitney Canada PT6A-67A as the powerplant for its G520NG high-altitude intelligence, surveillance and reconnaissance (ISR) aircraft. The G520NG is an upgraded version of the G520T Egrett, and the PT6A-67A is civil certified upto 45,000 ft (13,716m). Currently, the éG520T is powered by the Honeywell TPE-331-14F, which has a lower ceiling. Grob chose the PT6A "because of better worldwide support and increased time between overhauls." In addition to ISR, the civil-certified aircraft is also designed for high-altitude environmental test missions. It features modular payloads so it can accommodate new technology or different customer requirements.

Rockwell Collins' new helmet-mounted IDVS

Rockwell Collins has introduced its combat helmet-mounted Integrated Digital Vision System (IDVS) for warfighters, which is an advanced display system that combines real-time mission data with multispectral vision sensors into one view for greater situational awareness. The IDVS is the first hands-free helmet-mounted display system that fuses incoming data from various sources, such as a command centre, other warfighters or UAS, with multispectral vision. The system does this while automatically transitioning from dark to light environments in real time, allowing users to have a complete view of everything that is happening around them. IDVS builds upon Rockwell Collins' vision technologies for aerospace and defence, including the F-35 Lightning II helmet and civil aircraft head-up displays.

Elbit to supply SPECTRO XR systems

Elbit has been awarded a contract valued at over $90 million from "an Asia-Pacific country", for the supply of SPECTRO XR advanced electro-optic systems, which is an ultra-long-range, day/night, multi-spectral electro-optical ISTAR system. This is essentially a large multi-spectral imaging system combining multiple cameras into one, allowing SPECTRO XR to significantly improve performance without increasing size and weight. The system can be installed on a variety of platforms including rotary and fixed-wing airborne platforms, aerostats, naval vessels and land applications. A wide variety of command and control interfaces enables simple integration of the SPECTRO XR with various other systems onboard, such as mission computers, radar, data-links and helmet-mounted tracking systems.

Latvia orders RBS 70 missiles

Saab has received an order for RBS 70 missiles from the Republic of Latvia, with deliveries to take place during 2016-2017. Latvia has been an RBS 70 customer since 2004, and in 2015 Saab signed a contract with the Latvian Ministry of Defence for deliveries of RBS 70 missiles. The Saab portfolio of short-range ground-based air defence missile systems includes the RBS 70 and the latest version, RBS 70 NG. The RBS 70 system has an impressive track-record on the market with more than 1,600 launchers and over 17,000 missiles delivered to nineteen countries.

Carl-Gustaf ammunition for US military

Saab has received an ammunition order from the US Department of Defence (DoD) for the Carl-Gustaf man-portable weapon system, known as M3 MAAWS (Multi-role, Anti-armour Anti-personnel Weapon System), valued at $ 5.4 million. The order is under the terms of Saab's framework contract with DoD in August 2014 for the 84-mm recoilless rifle system. The latest version, the Carl-Gustaf M4 (called M3E1 in the US), reduces the weight from 10 kg to less than 7 kg and is designed "for soldiers operating in demanding environments."

Type 26 Gun System for RN

BAE Systems has received a $245 million contract to provide the Maritime Indirect Fires System (MIFS), for the Type 26 Global Combat Ship. Under the contract, the company will

manufacture three MIFS Integrated Gunnery Systems (IGS) and one trainer system for the Royal Navy. The MIFS IGS includes the 5-inch, 62-calibre Mk 45 Mod 4 Naval Gun System, along with an automated ammunition handling system, gun fire control system, and qualified ammunition. The contract includes an option for five additional systems for the remainder of the Royal Navy's Type 26 fleet.

Controp's new (HD) EO/IR Camera Payload

Controp has unveiled the Shapo-HD high definition EO/IR camera payload for helicopters, which completes Controp's family of EO/IR payloads with HD capabilities, including the DSP-HD, the Quad-HD and now the new Shapo-HD. The new payload is the HD version of the current Shapo system, which is installed on the Bell 206 and AS350. The Shapo-HD is a compact and lightweight (9.4" diameter 24 lbs.) payload, which includes a high resolution Thermal Camera with x15 continuous zoom lens, HD colour continuous zoom day camera with low light mode and a laser range finder and\or laser pointer as options.

IAI's new Unmanned RoBattle System

The IAI RoBattle unmanned, heavy duty, highly maneuverable combat and support robotic system "is designed to be integrated with tactical forces in mobile, dismounted operations and support a wide range of missions including intelligence, surveillance and armed reconnaissance; convoy protection, decoy, and ambush and attack." The RoBattle, the newest member of the family of unmanned ground robotic systems from IAI, is equipped with a modular "robotic kit" comprised of vehicle control, navigation, RT mapping and autonomy, sensors and mission payloads. The system can be operated autonomously in several levels and configured with wheels or tracks, to address the relevant operational needs. According to IAI, "Operators can equip RoBattle with different payloads including manipulator arms, Intelligence, Surveillance and Reconnaissance (ISR) sensors and radars, and remotely controlled weapons.

IMDO and MDA complete integrated ground test

The Israeli Missile Defence Organisation (IMDO) in tandem with the United States Missile Defence Agency (MDA) and the United States European Command (EUCOM) conducted an Integrated Ground Test, validating the combined United States/ Israeli Missile Defence integrated architecture for Israel's defence. The test was carried out by Elisra, a subsidiary of Elbit Systems. The integrated architecture consisted of the Israeli Arrow Weapons System using Arrow-2 and Arrow-3 interceptors, and the David's Sling Weapon System interoperating with the United States assets consisting of Command and Control elements, Aegis ships, Terminal High Altitude Area Defence (THAAD) and Patriot missile defence systems. The David's Sling missile defense system also participated in the drill as part of its transition to becoming operational.

MBDA Italia missiles for Qatar Emiri Navy

MBDA Italia has signed a contract for more than 1 billion euros to supply the Qatar Emiri Naval Forces (QENF) with missiles for their new naval vessels recently procured from Fincantieri. MBDA will be supplying the QENF with Exocet MM40 Block 3 anti-ship missiles as well as Aster 30 Block 1 and VL MICA air defence missiles. As Antonio Perfetti, Managing Director MBDA Italia commented: "This contract represents a further confirmation of the significant role that MBDA plays in the missile sector, not only in Europe, but also worldwide. It is proof of MBDA's capability, thanks to its very comprehensive portfolio of world class solutions, of being able to address the most stringent and diverse of customer missile systems requirements."

France and Italy to develop Aster 30 Block 1 NT

Italy's Minister of Defence, Roberta Pinotti, and his French counterpart, Jean-Yves Le Drian signed a 'Cooperation Arrangement' agreement to pursue the joint development of the

Aster 30 Block 1 NT missile. The Aster 30 Block 1 NT programme comprises, in addition to the upgrade of the Aster missile, the modernisation of the SAMP/T systems currently in service with the French Air Force and the Italian Army. These systems incorporate enhanced capabilities notably against ballistic missiles.

Rockwell Collins to modernise US test ranges

Rockwell Collins has been awarded a $31 million contract by the US Department of Defence to support production of the Common Range Integrated Instrumentation System (CRIIS) across Air Force, Navy and Army test ranges. Thus, Rockwell Collins is prime contractor and systems integrator for the next-generation military test range instrumentation system that will replace the Advanced Range Data System (ARDS) currently in use at major US military test ranges. Rockwell Collins will deliver 180 ground and airborne subsystems to seven DoD test ranges, initial spares to establish a repair pipeline for system support and support site activation with production hardware at NAS Patuxent River, Eglin AFB, Edwards AFB and White Sands Missile Range.

Raytheon projects future of Missile Defences

Raytheon has provided the US Army its vision of the future missile defence technology, a comprehensive next generation air and missile defence radar. This is part of its process to define the requirements for a future Lower Tier Air and Missile Defence Sensor. Raytheon's GaN-based AESA LTAMDS radar is designed

to serve as a sensor on the Integrated Air and Missile Defence Battle Command System network. It will be fully interoperable with NATO, and also retains backwards compatibility with both the current Patriot system and any future system upgrades fielded by any of the 13-nations that currently own Patriot.

Rafael equipment for Lithuania's Boxers

Rafael Advanced Defence Systems Ltd will supply its advanced Samson Mk II Remote Weapon Stations to the Lithuanian armed forces, as part of a deal that was signed to provide Lithuania with 88 high-protection Boxer vehicles starting in 2017. The Samson Mk II is a dual-axis, gyro-stabilised, dual-sight (Gunner and Commander) remote-controlled weapon system capable of mounting multiple weapons. The Samson Mk II offers significant improvements, including lower silhouette, add-on armour protection, and improved hit accuracy, boosted crew survivability with under-armor reloading and increased rigidity. Rafael will deliver the Lithuanian army Samson Mk II RWS systems with a 30mm automatic cannon, 7.62 mm coaxial machine gun, with Rafael's Spike LR (Long Range) ATGM launchers carrying two missiles and eight smoke grenade launchers on each station.

The Lightning Strikes !

MBDA ASRAAM production order for UK'S F-35s

The United Kingdom's Ministry of Defence (MoD) has awarded MBDA a £184 million production contract for the supply of the highly capable infra-red (IR) guided air-to-air missile, ASRAAM, to equip the UK's F-35 Lightning II stealth fighter jet.

ASRAAM is the Advanced Short Range Air-to-Air Missile (ASRAAM) in service with the RAF on the Tornado and Typhoon and, in time, the F-35B serving both the Fleet Air Arm and the RAF. Overseas users include the Royal Australian Air Force on the F/A-18 Hornet and it is on order for the Indian Air Force's Jaguars.

ASRAAM will be the first British designed missile to enter service on the F-35. ASRAAM's large rocket motor and clean aerodynamic design gives it high kinematic capability to deliver 'superior end-game performance' compared with other countries' in-service IR missiles.

MBDA is currently also under contract for an ASRAAM capability sustainment programme for the Typhoon and this new order to equip the F-35 will see the production of additional missiles. "Value for money is ensured through the re-use of components from other MBDA products such as the Common Anti-air Modular Missile (CAMM), whilst also ensuring the benefits of a single IR missile across the fast jet fleet is retained."

The missiles will be produced at MBDA's new £40 million Bolton manufacturing and assembly site with engineering activities carried out at MBDA sites in Stevenage and Bristol. The overall ASRAAM programme, combined with associated workload around domestic and export programmes using the core CAMM system, is employing 400 skilled employees across the MBDA sites and the UK complex weapons supply chain. Collectively these orders also ensure that ASRAAM remains available for overseas customers and future exports.

F-35 Lightning II's Weapons Tested

The F-35 Integrated Test Force (ITF) at Edwards Air Force Base, California, have completed 25 missions comprising 12 Weapons Delivery Accuracy (WDA) and 13 Weapon Separation Tests as part of

F-35 test pilot Maj. Douglas 'Rosie' Rosenstock, live fires an AIM-120 Advanced Medium Range Air-to-Air Missile above the Point Mugu Sea Test Range, California

a month-long weapon's firing test surge. Historically, WDAs take place once a month given the myriad of coordination required. The highest number previously accomplished in a month, was three in November 2014 during 2B software testing. These successful test events, performed using the F-35's newest block 3F software, demonstrated the accuracy of the F-35s. Five of the test events featured dropping of multiple weapons. The F-35 weapons test team was given exclusive use of the Sea Test Range, an instrumented Pacific Ocean test area off the central coast near Point Mugu Naval Air Station, California. Tests were also conducted at the US Navy's China Lake Weapons Range in California and the White Sands Missile Range in New Mexico.

During this unprecedented 'surge period,' a total of 30 weapons were dropped or fired, including the Joint Direct Attack Munition, AIM-120 Advanced Medium Range Air-to-Air Missile, GPS-guided 250-pound Small Diameter Bomb, AIM-9X Sidewinder air-to-air heat-seeking missile and GPS/laser-guided munition. "The WDAs rely on the full capability of the F-35, multiple sensors, navigation, weapons envelope, mission planning, data links and inter-agency range scheduling, all working in sequence to put steel on target," explained Lt Gen Chris Bogdan, F-35 Programme Executive Officer. "This was a tremendous effort by the F-35 test team. They surged and worked seven days a week for more than a month to expend 30 ordnance and advance weapons testing. This testing has moved us that much closer to delivering the full F-35 capability to warfighters within the next two years."

USAF declares F-35A 'Combat Ready'

The F-35A Lightning II fifth generation fighter aircraft has been declared 'combat ready' by General Hawk Carlisle, the commander of Air Combat Command.

Carlisle lauded the aircraft's performance, noting that the aircraft had met all key criteria for reaching initial operational capability: "Airmen trained, manned and equipped to conduct basic close air support, interdiction, and limited suppression/destruction of enemy air defences in a contested environment with an operational squadron of 12-24 aircraft; the ability to deploy and conduct operational missions using programme of record weapons and missions systems; and having all necessary logistics and operational elements in place."

The F-35A is the latest addition to ACC's fleet of deployable fifth generation aircraft. It provides air superiority, interdiction, suppression of enemy air defences and close air support as well as great command and control functions through fused sensors, and will provide pilots with unprecedented situational awareness of the battlespace that will be more extensive than any single-seat platform in existence.

"Bringing the F-35A to initial combat readiness is a testament to our phenomenal airmen and the outstanding support of the Joint Programme Office and our enterprise partners. This important milestone for our fighter force ensures the United States, along with our allies and international partners, remains prepared to deter, deny, and defeat the full spectrum of growing threats around the globe," added Deborah Lee James, Secretary of the Air Force.

Israel's first F-35 Lightning II in flight

The first Israeli Air Force F-35A Lightning II aircraft, known as the *Adir*, (meaning 'Mighty One' in Hebrew) flew its first Lockheed Martin company check flight from the F-35 production facility on 25 July.

First Israeli F-35A in flight

Numbered aircraft AS-1, the F-35 debuted in a rollout ceremony attended by Israel's Minster of Defence Avigdor Liberman, Brig Gen Tal Kelman, Israeli Air Force Chief of Staff and US Ambassador to Israel Daniel Shapiro, among other distinguished guests.The first F-35 *Adir* and aircraft AS-2, the Israeli Air Force's second F-35, will deliver to Nevatim Air Base, Israel, in mid-December to begin pilot training operations there. Israel's order is for 33 F-35A Conventional Take Off and Landing, or CTOL, aircraft, acquired through the US government's Foreign Military Sales (FMS) programme.

Now Operational ! Gripen MS20 with the Meteor

Saab, the Swedish Air Force and Sweden's Defence Materiel Administration have successfully implemented a revolutionary enhancement to the operational capabilities of the Gripen fighter. Among many significant new advances, Gripen is now the world's first – and only – combat aircraft to be operational with the MBDA Meteor BVRAAM missile.

Saab, the Swedish Air Force and Sweden's Defence Materiel Administration (FMV) have now certified, approved and accepted in to service the latest operational upgrade and combat enhancement for the Gripen fighter.

Known in Swedish terms as MS20, this upgrade is the latest step in Gripen's process of constant capability expansion. It puts a truly unique operational asset into the hands of Gripen operators. Speaking at the recently concluded Farnborough International Air show, at a ceremony to mark the Meteor's entry into service, Major General Mats Helgesson, Chief of Staff of the Swedish Air Force said, "After extensive testing by FMV and the Gripen Operational Test and Evaluation unit, all of the new MS20 functions including the Meteor missile are now fully integrated with Gripen. The Swedish Air Force is now in its Initial Operational Capability phase with the Meteor. The Meteor missile is currently the most lethal radar-guided missile in operational service, and the Swedish Air Force is the only operational user so far. I am very proud and satisfied to have the Meteor in the inventory of my air force."

The complete MS20 upgrade is now cleared for Swedish Air Force Gripens and MS20 enhancements will soon be implemented in Gripens of the Czech Air Force. The upgrade delivers a host of new capability options for air-to-air, air-to-surface and ISTAR missions plus many improved mission systems and other changes. As ever with the Gripen, operators are free to choose how, when and to what extent they implement the new capabilities that the upgrade enables. A key element of Gripen's MS20 capability expansion is full integration of the MBDA Meteor BVRAAM (Beyond Visual Range Air-to-Air Missile). The ramjet-powered Meteor, developed by MBDA with Saab as key partner, is an advanced, long-range and agile air-to-air weapon that is uniquely designed to counter the most sophisticated airborne threats of the 21st century.

Gripen with MBDA's Meteor (photo: Angad Singh)

Tactical missile with strategic effect

"Meteor tactical missile with strategic effect. It's extremely long range (beyond 100 km) and unrivalled with "no escape zone" (three times greater than any current BVR missile) and will dominate the future air-to-air battle space,giving a decisive capability to Gripen and its pilots", stated company officials.

Saab CEO Håkan Buskhe added, "Saab greatly appreciates our good relationship with MBDA both as a partner for Meteor development and production, and through our close cooperation on the Meteor integration programme for Gripen. This partnership has been the foundation for the delivery and deployment of a superior missile product. The Gripen played a major role in the Meteor development project, and we are very proud to have Gripen as the first fighter to take Meteor into service."

In the air-to-ground role MS20 delivers further significant enhancements. This includes integration of the Boeing GBU-39 Small Diameter Bomb (SDB) for a high-precision, long-range strike capability. A smart launcher can carry four SDBs, with a maximum of 16 on a single Gripen. Gripen's ISTAR (intelligence, surveillance, target acquisition and reconnaissance) capabilities are expanded through a modified reconnaissance pod that provides infra-red sensors plus real-time display of images in cockpit and increased data recording.

A further improved Link 16 datalink system supports a significant increase in data exchange between other fighters and C2 nodes. This boosts situational awareness and underpins new air-to-air and air-to-ground capabilities, including high-precision 'digital' CAS (close air support).

Among other MS20 pilot-centred enhancements are a new ground collision and avoidance system (GCAS) to protect the aircraft in demanding low-altitude environments and an improved CBRN system that allows Gripen to stay operational and effective in the event of a chemical, biological, radiological or nuclear attack.

"Gripen is developed with the long-term future in mind. It is designed for continuous upgrades to take on and defeat new combat challenges – a design approach that has already been proven many times. The implementation of MS20 opens a further chapter in this story, making significant new capabilities available to future users and the current Gripen family alike," stated Saab's CEO.

Trainer with Russian lineage – for USAF?

A Yak-130 showing off its impressive stores fit

In a strange turn of events, the US Air Force may acquire a new trainer aircraft descended from the Russian Yak-130. Raytheon and Leonardo-Finmeccanica are participating in the USAF's T-X future lead-in fighter trainer (LIFT) programme with their T-100 training system, based around the Leonardo-Finmeccanica (formerly Alenia Aermacchi) M-346 Master trainer. A T-100 mockup was displayed at the Farnborough International Airshow 2016 (*see Vayu IV/2016*) and an M-346 also took part in flying displays.

However, the aircraft traces its origins back to a joint Italian-Russian programme that began in the early 1990s. At that time, the Yak-130 was under development in Russia, and Italy's Aermacchi sought to modify and market the trainer in the West. However, the cooperation broke off in mid-2000, with both companies proceeding to complete development independently. As such, the M-346 looks all but identical to the Yak-130, but features all-Western avionics, a different digital flight control system, and Honeywell F124 turbofans, which have resulted in different kinetic characteristics, including its ability to go supersonic.

Russia's Irkut Corporation, where the Yak-130 is produced, also stresses that the type's Russian and Western descendants are in fact different aircraft. Today, the M-346 is one of the Yak-130's chief rivals on the export market. The Yak-130 is in service with the Russian Air Force in large numbers, and Algeria, Bangladesh and Belarus also operate the type. The M-346 is operated by the Air Forces of Italy, Israel, and Singapore, with Poland set to receive its first example later this year.

"Understandably, the planes resemble each other only externally, while internally they are really different," said Andrei Frolov, editor of the 'Arms Exports' journal, a Russian analytical magazine published by the Centre for Analysis of Strategies and Technologies. "Besides, the M-346 is in fact a fighter trainer, while the Yak-130 is also positioned as a light fighter or an attack aircraft. The Russian aircraft can use a whole range of guided and un-guided armaments, being able to carry out a wider range of missions in comparison with its Western counterpart."

But the "copying" of the Yak-130 is an endorsement of the type's fundamental performance characteristics, believes Frolov, who said, "Besides the Italians and Americans, the same is being done by the Chinese. This proves that the Yak-130's aerodynamics and construction are so good that they have become a sort of standard in the field of development of combat trainers and light combat aircraft !"

The Russian expert stresses that the Yak-130 is a trainer first of all, and is reliable, easy to run and customer-tailored. The fully-digital Yak-130 makes it easy to understand by trainee pilots, and allows for any aircraft to be imitated during a training sortie. If a cadet is being trained for the Su-35, the Yak-130 flies in 'Su-35 mode,' if the training is for MiG-35s, then it uses that mode, and so on. Russian Air Force experts say the training process on the Yak-130 is completely predictable for both the trainee and instructor. The trainer is capable of an angle of attack up to 40 degrees, with speeds between 200 km/h and 800 km/h.

For combat roles the Yak-130 easily transforms into a light fighter or attack aircraft. There are nine external stations capable of carrying 3,000 kg of combat load, including both air-to-air and air-to-surface munitions. Experts predict that for certain combat missions the Yak-130 would be many times more cost-effective than a Sukhoi or MiG aircraft.

Russian newspaper Izvestia quoted Irkut President Oleg Demchenko as saying "Our aircraft has actually set a sort of standard for all combat trainers nowadays. The aircraft is in fact at the initial stage of its life cycle and will be manufactured and further developed for years to come. We see a stable demand for Yak-130s in Russia and abroad. The Russian AF will get soon its first hundred Yak-130s, while there are dozens flying overseas. I am confident we will get new contracts."

(With inputs from Izvestia)

An armed M-346 demonstrator at the Farnborough International Airshow 2016 (photo: Angad Singh)

Russia's New Airliner

On its way to India?

Having been rolled out on 8 June (*see Vayu IV/2016*), Russia's newest airliner, the MC-21-300 narrowbody, has acquired a new customer – Azeri flag carrier AZAL which has signed for ten such aircraft. Noting that Azerbaijan's capital Baku is half way from Moscow to Mumbai, one may assert that the 180-seater may next time land in India and win orders there too!

Sales of modern jetliners to India were among other topics discussed at a press conference hosted by United Aircraft Corporation on 12 July at the Farnborough International Airshow 2016. UAC President Yuri Slyusar said that "the rich experience of successful programmes that Moscow and New Delhi have amassed in the domain of military aviation could facilitate market entry for Russian civilian products." Besides, well-established industrial cooperation with HAL and other local manufacturers makes UAC believe in the applicability of 'Make in India' rules to would-be programmes for licence production and co-development of civil aircraft.

The UAC President used Farnborough as a convenient platform to brief international media on the MC-21 programme status and plans. In his words, the June rollout was "a key milestone" and "a very important event, for which we had been waiting so long." The programme started in earnest in 2007, almost ten years ago. "The operable prototype that rolled out last month was made using the very same technologies that will be used in future to manufacture deliverable examples," he said. The next target is first flight, which Slyusar expects to happen in the first half of 2017. UAC plans to produce four deliverable jets in 2017, ramping up to twenty by 2020, before attaining the assembly line's capacity of seventy MC-21s per year in 2023.

An aircraft family

Developed by the Moscow-based Yakovlev design bureau, the MC-21 is in production at the Irkutsk Aviation Plant (IAZ) located in Irkutsk, Western Siberia. UAC subsidiary Irkut Corporation controls both Yakovlev and IAZ, making the MC-21 essentially an Irkut product. Apart from the baseline MC-21-300, the aircraft family also includes the smaller -200 model with 150 seats and the stretched -400 variant with 220. Catalogue prices for the MC-21-300 and Airbus A320neo, both available with Pratt & Whitney PW1000G-family Geared Turbofan (GTF) engines, are US$ 85 and 107 million respectively.

The MC-21-300 is powered by a pair of PW1400Gs from the PW1000G family of GTF engines, whichYuri Slyusar described as "the most modern engines built to the innovative geared fan concept." PW1000G-family engines are already in service on the Bombardier CSeries and Airbus A320neo, both of which commenced revenue flights earlier this year.

As an option, the MC-21-300 is offered with the PD-14 turbofan developed by

the Aviadvigatel design house in Perm. "Our colleagues from the United Engine Corporation pledge to acquire type certificate in 2017 from the Air Register of Interstate Aviation Committee (CIS civil aviation authorities). Their next target is timed for 2019-2020, when, after additional testing is complete, they shall win a complimentary certificate for use of that engine on the MC-21," stated Slyusar. The UAC President believes that "a choice of two engines is better than having no alternative !" This makes the new airliner even more attractive to airline customers "who can choose a configuration that suits them best."

Advanced materials – and techniques

Technically, the MC-21 employs many innovative technologies. Its airframe features a fuselage made of Aluminium-Lithium and other advanced metallic alloys using state-of-the-art manufacturing equipment from Broetje, Durr, Premium Aerotec, Demag, Hymer and other European firms.

The share of composite materials in the MC-21 structural weight is at 40-45% compared to 10-15% for airliners of previous generations. Composite parts for the aircraft are supplied by recently established factories in Ulyanovsk and Kazan run by state-owned AeroComposit (*see Vayu I/2016*). These parts are made using the revolutionary technology of vacuum infusion (developed jointly with Hexcel, Diamond, FACC AG and other western firms). This provides a sharp contrast to all other airframers, including Airbus and Boeing, who continue to rely on the classic manufacturing methods that necessitate use of big, expensive autoclaves.

The all-composite wing is notably lighter than a metallic equivalent, and contributes 8% to the MC-21's combined 20% better fuel efficiency over in-service aircraft. To make 20-metre-long wing components, AeroComposite uses an automated system to lay down a pre-form as a set of twenty-four carbon belts, each 6mm wide. Then it goes into a so-called vacuum sack, where the binding resin is applied. Curing is completed in a special heating device, different from typical autoclaves as it generates lower temperatures. The manufacturer asserts that no other technology makes it possible to manufacture the wing of that aspect ratio with the desired lift/drag ratio and weight efficiency.

Gambling on technologies such as vacuum infusion seems inevitable for a manufacturer that is seeking to achieve a substantial boost in flight and cost performance in the domain of narrow body jets. The new technology promises substantial cuts in manufacturing costs. Even though it is yet to be declared mature enough for mass production, AeroComposit has already manufactured several sets of composite parts for testing and operable prototypes.

When the show at Farnborough was underway, a set of wings for static testing arrived at TsAGI (*Tsentralniy Aerogidrodinamicheskiy Institut*, Russia's Central Aerohydradynamics Institute). Having revealed this information, Yuri Slyusar stated: "The MC-21 wing is made of composite materials using modern diffusion technologies without involving autoclaves. The on-going tests on both the prototype and wing specimens are to make sure the newly manufactured wings are up to the advertised performance, and that design targets are fully met. We are immensely proud of the work our employees have done on these technologies, their implementation and making of the first sets of wings. From the scientific, technical, technological and innovative points of view, the work done deserves the highest praise. What's left is to prove in tests that the wing performs up to our expectations. Ahead of us lays a very tense period of preparations to maiden flight, which is expected in the first half of the year 2017."

Russian Deputy Prime Minister responsible for defence industry Dmitry Rogozin (tallest, centre) at the IFC/AZAL signing ceremony on 8 June 2016

On 8 June, Azerbaijan Airlines (AZAL) signed for ten MC-21-300s. From left to right in this photo: UAC President Yuri Slyusar, Ilyushin Finance Company CEO Alexander Roubtsov, and AZAL CEO Jahangir Askerov

The second prototype at the final assembly line in Irkutsk

The Indian market

One of the many motivations the Indian airlines may have towards taking the MC-21 is the fact that the production line of this jet is being set up at IAZ, which has been a major supplier to the Indian Air Force for about fifty years. The first product delivered to India from here was the Antonov An-12 tactical airlifter. Later on, IAZ supplied MiG-23UB operational trainers and kits of MiG-27 strike aircraft for assembly at HAL's MiG Complex in Nasik.

Today, the plant makes kits of the Sukhoi Su-30MKI multirole fighter for final assembly at HAL's Nasik facility. This type forms backbone of the Indian Air Force, equipping the majority of its operational fighter squadrons. Out of 272 Su-30MKIs contracted for – either flyaway, in the form of kits, or licence built – over two hundred have been delivered. The last kit on order shall be shipped in 2017. When this writer visited the plant in June 2016, he was told that negotiations were underway to increase the grand total of Indian Su-30MKIs to "over three hundred units."

Reportedly, the Indian Air Force is very happy with the Su-30MKI's performance and generally satisfied with their support, which fact Russia is trying to explore in the on-going marketing campaign for the MC-21. "We make superb combat jets, so why can't we make a good passenger plane?!" is the sort of argument MC-21 sales managers have been using in talks with Asian customers. They seem to have successfully employed it in negotiations with CRECOM, having talked this Malaysian company into signing for 50 MC-21s in 2010.

[Detailed report on the MC-21's commercial prospects to follow in the next issue]

Text and photos: Vladimir "Vovick" Karnozov

P&W 1400G engines and their nacelles at the IAZ plant

Irkut delivers MC-21 fuselage for static tests

Russia's Irkut Corporation has delivered an MC-21 fuselage designated for static tests to the Central Aero-Hydrodynamic Institute (TsAGI). The fuselage will confirm the strength characteristics of the new aircraft and will help provide certification of the type for static strength.

The MC-21 fuselage was transported from Irkutsk to TsAGI at Zhukovsky by an An-124 freighter. Other parts of the airframe, such as the auxiliary power unit compartment, will be delivered to TsAGI over the coming months, and Irkut specialists, together with employees of TsAGI and other companies involved in the MC-21 programme, will perform airframe assembly at Zhukovsky.

The first stage of the airframe test involves leak inspections. Then TsAGI will initiate static tests, which include simulation of structural loads in all flight modes with registration of the aircraft structure's stress-strain state. The tests will provide experimental corroboration of static strength and verify theoretical airframe strength calculations, and also allow for fine-tuning of the finite element models based on experimental data. TsAGI has already conducted tests on a large number of representative MC-21 sub-assemblies, including several types of panels and joints, and testing of many other parts is currently underway. Preparations are also being made to begin testing the all-composite wing-box, stabilising fin and high-lift devices.

On-going and planned tests will verify the ability of the new MC-21 aircraft structure to withstand design loads without failing or being deformed, and as such are a crucial part of the comprehensive test campaign being implemented before the new airliner's maiden flight and subsequent certification.

French Navy bids adieu to SEM

On 12 July 2016, the last official flights of the French Navy's Dassault Super Etendard Modernisé (SEM) took place at *Base d'aéronautique navale de Landivisiau* (BAN Landivisiau).

French Navy Super Etendards have participated in nearly all regional conflicts since the 1980s, proving to be invaluable strike assets. The aircraft are described as "reliable, easy to maintain and simple to fly." Following their last combat cruise on board *Charles de Gaulle*, during which they conducted anti-ISIS strikes (*Operation Chammal*) from the Mediterranean Sea and the Persian Gulf, the final Super Etendard Modernisé catapult launch took place in March 2016. The aircraft were then based ashore, in anticipation of formal withdrawal from use in the French Navy.

After 42 years of service (for all Etendard variants) three SEMs – one in the current two-tone matte grey camouflage, one painted silver, and the third in the French Navy's older glossy blue with white underside – took off from Landivisiau to mark the type's formal withdrawal from service.

The silver and two-tone grey SEMs conducted a formation flypast together with their successors, two Dassault Rafale Ms,

The final SEM display over Landivisiau

and an E-2 Hawkeye from the nearby Lahn-Bihoue naval air base. The blue-and-white Super Etendard then carried out a short display to end the type's flying career. The three aircraft then landed and were parked near the audience, while the pilots disembarked and received a traditional French champagne shower.

Five Super Etendards were airworthy with five pilots available on the final day of SEM operations. The following week saw the aircraft flown into storage, their fates unknown, although they are expected to be kept in flyable condition.

Flotille 17F with Rafale Ms

The last French Navy Etendard squadron was Flotille 17F, and on 13 July, the day after the Etendard retirement, it became a Rafale M squadron with a new commander (a Rafale pilot). 17F will become fully operational with the Rafale in 2018, as

SEM in two-tone camouflage taxiing past the shelters at Landivisiau

experienced pilots transfer in and younger pilots take time (about a year) to become fully operational on the new type. Owing to maintenance being carried out on the French aircraft carrier *Charles de Gaulle* (R91), which will take around 1.5 years, the squadron will obtain carrier experience in cooperation with the US Navy.

The other two French Navy fighter squadrons, Flottilles 11F and 12F are already operational with the Rafale, and once 17F is ready in 2018, the French Naval Aviation arm (*Aéronavale*) will have an all-Rafale fighter force. The French Navy eventually plans to have one Flottille in training, one in full operational readiness, and the third in partial readiness, with the units rotating each year. In case the need arises, both operational Flottilles can be exploited either on board *Charles de Gaulle* or from shore.

Text: Joris van Boven and Alex van Noye
Photos: Joris van Boven


The Rafale M is now the mainstay of the Aéronavale's fighter force

Bastille Day 2016

On 14 July 1789, the people of Paris raided the Bastille prison, an event that started the French Revolution. To commemorate this day, a military parade (*défilé*) is held annually along the Avenue des Champs-Élysées in Paris with marching soldiers, trucks and tanks, while overhead aircraft and helicopters conduct a spectacular air parade (*défilé aérien*).

This year, aircraft flew from various airbases across France. Some types operated from their home bases (C-130, A400M, E-3F, C-135F, French Navy fighters), and others from airbases closer to Paris–if fuel was a factor (BA 105 Evreux for fighters and transports, BA 107 Villacoublay for Air Force helicopters, and BA 110 Creil for Army and Navy helicopters).

BA Evreux

On the morning of 14 July, *Base Aérienne* (BA) 105 Evreux hosted a photographers' day to cover the flight preparations and take-offs of most of the fighters that would be flying over Paris for the Parade. Rafales, Mirage 2000s and AlphaJets departed for Paris, while stand by aircraft conducted pre-flight preparations but only left Evreux after the parade was over. All fighters returned directly to their home bases afterwards, while a locally based Transall C-160 and a CN235 returned following their flypasts.

The most special participant at BA Evreux in 2016 was a Mirage 2000N of EC 2/4 'La Fayette,' specially painted to commemorate the Squadron's centenary. This aircraft also served as lead of the Ramex Delta demonstration team, which carried out its last display season this year.

Specially-painted La Fayette Squadron Mirage 2000N taking off from the rain-soaked runway at Evreux

Rafales and AlphaJets parked at BA 105 Evreux

Défilé

During the *défilé* over Paris, all flying types of the French Air Force, Navy and Army were shown: tactical aircraft, air-defence fighters, strategic aircraft and support types such as tankers, transports and surveillance aircraft.

After the fixed-wing aircraft, the helicopters made a flyby overhead Paris, highlight of this portion was a formation of a US Air Force Lockheed Martin MC-130J simulating refueling with two Airbus EC725 Caracal helicopters (*see lead image*). The French Air Force is acquiring a number of MC-130Js to ensure air-refueling capability for the Caracal helicopters.

Text and photos from Evreux:
Joris van Boven
Parade photos: Claude Parotte

Three Rafale Ms lead an E-2C over Paris

F-35A in the Netherlands

Late in the evening of 23 May 2016, two Royal Netherlands Air Force (RNLAF) Lockheed Martin F-35A Lightning II fighters (F-001 and F-002, tailcoded 'OT') landed at Leeuwarden air base, marking the first West-to-East trans-Atlantic crossing of this aircraft. The aircraft made the non-stop journey assisted by a pair of Dutch KDC-10 tankers.

On the evening of their arrival, the formation of KDC-10s and F-35s was accompanied escorted in for the last part of the journey by two Dutch F-16s and a Gulfstream IV VIP transport with Defence Secretary Jeanine Hennis-Plasschaert and Commander of the Dutch Air Force Lt General Alexander Schnitger on-board. The formation conducted several flypasts over Leeuwarden before the aircraft touched down one by one. The Gulfstream was first to land, in order to allow the Defence Secretary and the RNLAF Chief to formally welcome the two F-35 pilots. The F-35s themselves touched Dutch tarmac for the very first time after sunset, bringing their 8-hour flight from NAS Patuxent River in the USA to a close. The two pilots, Colonel de Smid (call sign 'Vidal') and Major Smaal (call sign 'Smiley'), were greeted by a water cannon salute by the local fire department and were welcomed by Secretary Hennis-Plasschaert and Lt Gen Schnitger on the tarmac.

The aircraft stayed for three weeks to carry out a range of ground and air tests, and at the end of their stay participated at the Open Day of the Dutch Air Force at Leeuwarden AB on 10-11 June 2016.

The route

The two F-35s flew the entire route accompanied by a pair of KDC-10 tanker aircraft for air-to-air refueling. They departed Edwards AFB in California on

21 May for NAS Patuxent River, before heading across the Atlantic Ocean for the Netherlands early in the morning on 23 May. During the Atlantic crossing, the F-35s were refueled three times by each accompanying KDC-10.

Testing

A number of tests were conducted during the F-35s' stay in the Netherlands, including noise testing and compatibility test with Dutch aircraft shelters. The fighters also participated in limited training missions, and had their logistics footprint assessed.

The aircraft shelter testing was first to begin. Right after landing, one of the F-35s was fitted with measurement equipment and placed in a Hardened Aircraft Shelter. Several tests were done to compare sound levels, vibrations, air quality, and behaviour of equipment when the F-35 is started up inside a shelter or outside. The results of these tests will be available shortly.

Reports in the Dutch press regarding comparatively higher noise levels of the F-35 led to some concerns among civilian populations near Volkel and Leeuwarden, the two designated RNLAF F-35 bases, currently operating F-16s. In order to assess any difference in perceived noise between the two aircraft, an F-16 and an F-35 operated from each base. The fighters conducted one set of flights in the afternoon and one in the early evening, so all nearby inhabitants could hear both aircraft. Similar take-off and landing patterns were flown by each aircraft, and local respondents were surveyed for their perceptions of the sound.

A rough analysis has revealed that noise levels of the two fighters are broadly comparable. In practice, a major differences between the two types is that an F-35 does not need afterburner for take-off, even fully loaded with weapons and fuel, whereas the F-16 requires reheat when fully loaded. While the noise testing was carried out with both aircraft in reheat, the F-35 is expected to use reheat much less often during actual operations.

Public Display

As a public relations effort, a short cross-country flight was planned for both F-35s on 2 June 2016, to visit all active RNLAF air bases, allowing the public at large to see the aircraft. Bad weather pushed this flight to 7 June, but the Dutch took the opportunity to visit more places and give more people in the Netherlands an opportunity to see the new fighter. The F-35s criss-crossed the

country for around four hours, flying over thirty towns and cities before returning to Leeuwarden.

Experiences

Dutch pilots are very enthusiastic about the performance and potential of the F-35. This is unsurprising, as there are some 30-35 years of aviation knowledge between these types; the first F-16 entered Dutch service at the height of the Cold War in 1979.

For instance, the senor fusion to create a 'virtual reality' for the pilot is "amazing compared to the F-16." In an F-16, and most 'legacy' fighters, the pilot has a Head-Up-Display (HUD) for the bulk of his critical information, but has to look inside the cockpit to check screens and dials. In an F-35, the helmet projects all aircraft information on the visor, so there is no need to shift attention to the inside of the cockpit.

Adding to the data available on the helmet, another key advantage is the 360-degree view in all directions. With cameras on the nose, tail and below the cockpit, the pilot can 'see' objects of interest in all directions, including downward. Anything relevant in the pilot's line of sight is projected on his visor.

New generation digital networking allows F-35s to be seamlessly inter-connected, sharing information and targeting data.

The future of air warfare using F-35s will be very different. A formation of F-35s will not stay close, but instead will spread out to cover much larger swathes of air and ground. By combining their sensor information, mission commanders will be able identify a larger pool of targets, capable of being engaged by the weapons of any of the fighters in the air.

'Writing the book'

One of the main tasks of the Dutch F-35 team during their trip to the Netherlands was to 'write the book' for future deployments.

What kind and number of spare parts were needed for immediate use, what kind and number could be ordered later and how fast would they reach Leeuwarden?

Since there is not much information on spare part lifetimes, the logistics crews needed to follow theoretical guidelines provided by OEMs. However, owing to the limited number of flying hours (about 400 hours per aircraft) there was a possibility that there might be some mis-match between theory and real-life ! Reliable predictions about spares and support are usually obtained after around 100,000 flying hours or more, so the Dutch deployment was used as a learning experience wherever possible. In fact, in order to test the logistical process, some parts were ordered without actually being needed, simply to see how long it would take for them to be made available.

Operational F-35s

The forty-seven F-35s on order will be delivered first to training air bases in the USA, to train instructors, pilots and ground crews. By 2019, the first F-35s should begin to be operationally based at Leeuwarden, with the remaining F-35s to be delivered to Volkel around 2021. The operational Dutch F-35s will be delivered from the Italian F-35 assembly line at Cameri, with only the two test aircraft having been built by Lockheed Martin in the USA. These two aircraft are similar to operational aircraft, but they have additional wiring inside to attach test-equipment to the test-computers.

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Book Reviews

Spitfire, Spitfire, Spitfire !

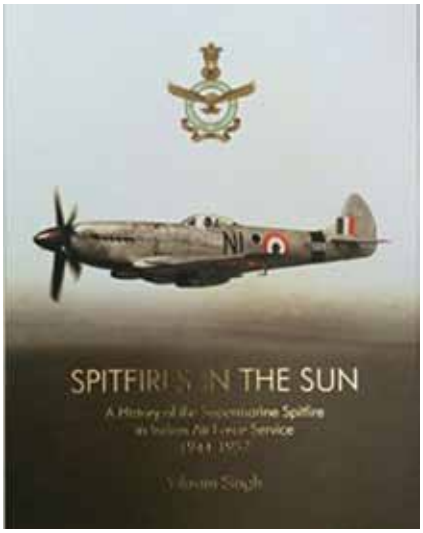
The Definitive History

60 years after the last Indian Air Force Spitfire (a PR Mk.XIX) was phased out, appears this definitive book '*Spitfires in the Sun : A History of the Supermarine Spitfire in Indian Air Force Service 1944-1957*' by Air Vice Marshal Vikram Singh (alias 'Polly' to his friends).

Polly is truly in love – with the Spitfire! The AVM is also 'total aviation person' (TAP) : not only is he a professional aviator, fighter ace and test pilot to boot (with also over 100 sorties in the LCA) but an aficionado of IAF's historical facts and photographs which he has assiduously sought and collected over decades. Vikram's particular areas of interest cover the 'Golden Age of Aviation', the '40s to the '70s, and although he has written for the internet on the IAF's Westland Wapiti, Hawker Tempest and the HF-24 Marut, that on his legendary father, Air Marshal Prithi Singh, was truly evocative, with the title summing it all up : 'The man who flew too much'.

Spitfires in the Sun is a self contained volume on everything about the Spitfire in India and particularly the Indian Air Force's Spitfires from their first arrival in the country in October 1942 to the phase out of the last IAF Spitfires in September 1957. This book covers a major gap in the history of the Spitfire especially the role of RIAF Spitfires in Burma, the fate of roughly 100 ex-RAF examples left behind after the war and also the 99 ex-RAF Mk.XVIIIs, seventeen PR Mk. XIX and ten T.Mk.IXs purchased after independence. The book provides detailed RAF-IAF tail numbers, strike off data of nearly 200 Spitfires, the myriad paint schemes and eclectic selection of markings and a detailed and up to date history of survivor restoration and status. Detailed unit histories gleaned from Squadron ORBs, first person accounts, 29 colour side views and rare photos and maps complete this one of a kind book.

The book is handsomely illustrated but not all sources are truly acknowledged. There are some 30 photographs which this reviewer either personally took or sourced from UK collectors but these are incorrectly attributed !



One should also confess that photographs taken by the reviewer of various IAF Spitfire types at the Air Force Museum, Palam in the late 1960s and later published in the *Air Enthusiast* magazine in England, 'blew the lid' to reveal the existence of these very rare Spitfires, including the exotic T.Mk.IX two seat conversion trainer. This immediately

Spitfire Mk.VIII 'Plumber' under restoration at the IAF Museum, Palam

attracted several vintage aircraft collectors from abroad (mainly the UK and America) who pretty quickly flew to India and in a manner of speaking, 'stole' these ! An unsuspecting, or uncaring, IAF allowed that to happen, as it was deemed that there were 'surplus' Spitfires at the Palam Museum anyway, not concerned that these were single examples of Mks VIII, IX, XIV, XVII and the XIX. Today, there is only the Mk.VIII left (NH-631 'Plumber') which is presently subject of Mike Edwards' restoration efforts.

Also for the record, it should be recollected that the first authentic account of Spitfires with the IAF were part of the book '*Aircraft of the Indian Air Force : 1933-73'* by Pushpindar Singh while a detailed article '50 years of the Spitfire', including a section on its service with the IAF, appeared in the *Vayu Aerospace Review* in April 1986, or some 30 years back.

Meanwhile, Polly's fans – and the reviewer is one of them – await even more gems from him in the near future !

Pushpindar Singh

Book : *'Spitfires in the Sun : A History of the Supermarine Spitfire in Indian Air Force Service 1944-1957'*

Author : Air Vice Marshal Vikram Singh

Pages: 188

Publisher: United Services Institute;

1st edition (2014)

ISBN-10: 8190359150
ISBN-13: 978-8190359153

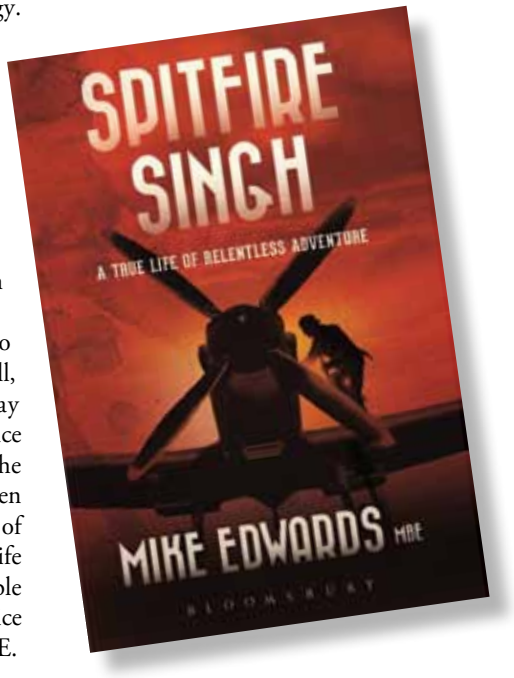
'Spitfire Singh'

Over 80 years ago, a unique event took place in history of the Indian subcontinent that was to subtly, yet irrevocably, alter the dynamics of the colonial relationship in India and give rise to a spirit of dynamism and resolute self-confidence within the rapidly burgeoning educated youth of the country. The event was the birth of the Indian Air Force on 8 October 1932. Although unheralded by any fanfare, the gazette notification that carried the announcement was a moment of great import. It signified a break from the old colonial principle of keeping Indians away from access to new military technology. Indeed, it was Indian blood, shed freely in the defence of the British Empire on the killing fields of the Great War that had forced a change in policy. The Skeene Committee of 1926 cited the example of the small band of Indian aviators who had served with the Royal Flying Corps in Europe as justification for the founding of an Indian Air Force.

In 1930, six young men were sent to England to train as pilots at RAF Cranwell, while 29 were recruited from railway workshops in India to train as apprentice aircraft hands. *Spitfire Singh* follows the trials and tribulations of these young men who formed the band of early pioneers of military aviation in India, through the life and career of one of the most remarkable amongst them: Hawai Sepoy (later Air Vice Marshal) Harjinder Singh VSM (I) MBE.

As one of the very first airmen of the IAF, who rose through the ranks to retire as the first Air Officer Commanding in Chief (AOC-in-C) of IAF. Maintenance Command, Harjinder's career spanned the ups and downs of the service from its humble beginnings as a fledgling single flight equipped with four vintage Westland Wapiti biplanes to its status as one of the major air forces in Asia at the time of his retirement in 1963.

It is a stirring tale of passion and commitment, told well by Mike Edwards, who has used extensive sources to document not just the life and times of



the subject of his biography, but also the service that was so integral to his being. Edwards recounts his story as a gripping narrative as he follows the frustrations and triumphs of the band of educated young men who gave up a life of ease and comfort to lay the foundations of India's air force. From the halcyon days of the camaraderie experienced by a close-knit Service at Kohat where the IAF received its baptism of fire in time-honoured fashion in operations on the erstwhile North-West Frontier, to the First Burma Campaign in 1942, where Harjinder worked tirelessly with his CO, the irrepressible KK 'Jumbo' Majumdar, to transform the IAF into a first-rate modern fighting force, the story grips the reader. The innovation of the Indian airmen under Harjinder's leadership that transformed the unarmed Lysander into a bomber capable of delivering a fitting reply to the Japanese is the stuff of legend and a notable achievement of India's air force.

Even more fitting in the current context is the manner in which Harjinder pioneered the 'Make in India' movement more than five decades ago when he rolled out the first Indian made aircraft—the Avro 748—from the Aircraft Manufacturing Depot at Kanpur in 1961. The author also captures the complex relationships that existed between many of the key players in the decade leading up to the debacle of 1962. The accounts of the dealings of the Defence Minister, VK Krishna Menon and his attempts to mould and bend professional military opinion to his will, make for very interesting reading.

In a departure from most narratives of the period the author provides readers with a gripping account of momentous times in India's history, and the men who shaped them, from a very different perspective — that of the birth and formative years of the Indian Air Force.

Sqn Ldr Rana TS Chhina (Retd)

Secretary and Editor, Centre for Armed Forces Historical Research

Book: *Spitfire Singh: A True Life of Relentless Adventure*

Author: Mike Edwards MBE

Publisher: Bloomsbury

Pages: 434

ISBN-10: 9384898678
ISBN-13: 978-9384898670

Romancing the Spitfire

This book is a well-narrated story of romance between Goro and the Spitfire. The Spitfire, in Goro's own words, is a fighter aircraft (not a mythological dragon) that won the Battle of Britain by defeating the German blitzkrieg.

The beginning of this romance is traced back to 14 October 1947 when young Goro reported for training as a Royal Indian Air Force pilot cadet at Jodhpur after his schooling at New Delhi and college education at Benaras. 'Goro' is the author's favourite sobriquet for Wing Commander SK Gorowala.

Rightly subtitled 'Memoirs', the 201-page book is a heartwarming spectrum of Goro's memories, passionately recoded, of his life from the time he reported for training to the end of his career in the IAF. One is impressed with his eye for minute details of whatever he describes as a part of his duties including funeral parades following fatal air accidents involving his colleagues. One notable example is the narration of Dining-in-Nights he had to attend at Jodhpur, an experience normally beyond the pale of a civilian.

With equal ease, he describes the object of his love: the Spitfire, a sleek aircraft with the Rolls Royce Merlin engine driving a powerful propeller with its 2200 horse power; its masterpiece design being the finest aerodynamically, climbing to 40,000 feet in a matter of minutes.

Having started his flying training on the basic Tiger Moth and advanced flying on Harvard, 100 hours of each respectively at Jodhpur and Ambala, Goro converted to the Spitfire ('good fun flying the Spit') in July 1950 at Ambala.

One peruses chapter after chapter of the narrative in the hope that the author's romance with the Spitfire will emerge as an iconic relationship. But nothing of the sort happens: it suddenly ends with his Spitfire crashing in his second solo flight at Ambala. What follows is the story of his visits to military hospitals, treatment of his right eye at the Poona hospital and getting to wear a black patch on it; his joining the Administrative Branch and becoming an ATC officer, his postings to Begumpet, Palam, Kanpur, Bangalore and Nagpur where he suffered a heart attack while in a flight to Delhi.

As a young cadet at Jodhpur, Goro fell in love with a pretty young lady, the daughter of a retired Railways officer. The aroma and fragrance of the romance–dancing and receiving a parting kiss on the cheek, the gift of a lock of her hair in an envelope did not last long reflecting, in a way, the unfortunate failure of his romance with the Spitfire !

All in all, Goro–'not a Parsi'–is an outstanding raconteur and has mastered the art of weaving gripping stories, true and credible, around fellow-patients at the Army Hospital in Delhi and the MH at Poona. His story about the UK Courier Dakota and its crashing during the return trip in the vicinity of Ankara is cinematic in impact.

A good read for anyone interested in knowing about life in the Indian Air Force in the early fifties and even today!

Gp Capt JC Malik, VSM (Veteran)

Book: *The Spitfire: Memoirs*

Author: Wg Cdr (retd) SK Gorowala

Publisher: Creative Crows Publishers, New Delhi 110024

Pages: 201

ISBN-10: 9384901210
ISBN-13: 978-93-84901-21-9

From the pages of IAF history

The Indian Air Force is 84 in 2016 : however the first cadets went for flying training to RAF Cranwell in 1930 and the initial six are seen in this unique photograph, along with their RAF instructor

Officers of No.1 Squadron (note 'Tiger' badge on overall) after return from the First Burma Campaign

IAF Flying Officer at the Willingdon Club, where the 'Tigers' were honoured by the Governor of Bombay

"Tigers of Imphal": No.1 Squadron officers during the campaign in 1944

Readers able to correctly identify these pioneers of the Indian Air Force will receive a year's subscription to the *Vayu Aerospace & Defence Review* ! We are waiting.... !

Air Vice Marshal Cecil Parker on

A Double Diamond Jubilee

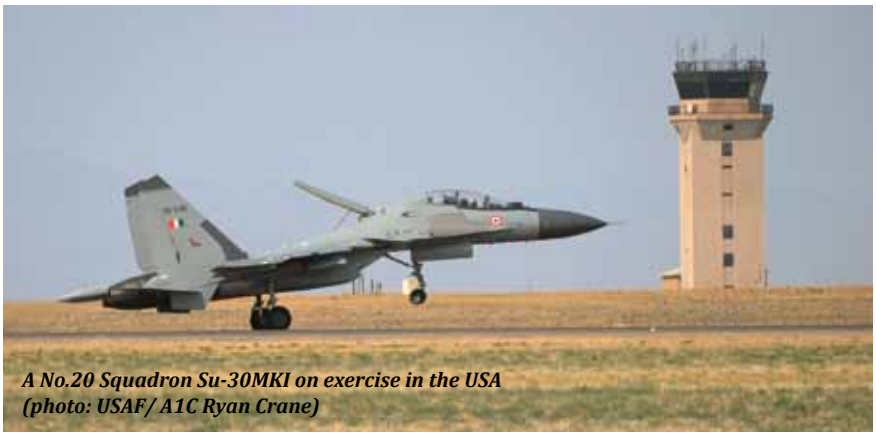
A creatively designed card from my old squadron invited us to join its Diamond Jubilee celebrations on 3-4 June 2016. On arrival, I realised that in my 84th year, I was the oldest and senior-most member present. All of us outstation members were looked after with meticulous care and were of course delighted to meet up again with old colleagues and friends. The programme, spread over 36 hours, comprised the traditional *Bara Khana* preceded by a talented variety show, the Dinner Party at the Officers' Mess and an Airshow-cum-Breakfast at the Squadron.

The unit was raised in 1956 and has lived up to its motto, 'Swift and Fearless,' in peace and war. From its insignia, it is known as the Lightning Squadron and from its number its members are labelled as 'Tribe Twenty.' In the past 60 years it has been equipped with a multitude of different aircraft types (Vampire, Hunter, MiG-21, Su-30MKI), was based on 10 different airfields in four operational command areas and has had operational, display and training roles. My own stay in the squadron, covering seven years in three ranks/appointments between 1962 and 1972, has been eclipsed by the present squadron commander who has served the unit for over nine years! In six decades the squadron has had 27 Commanding Officers, 20 of them still alive, of whom 10 (plus two widows) were present for the celebration.

Equipped with the Hunter Mk.56 and Mk.56A aircraft, the squadron participated in both the 1965 and 1971 wars winning a collective two MVCs, eight VrCs, and two VMs making it the most highly decorated squadron in the Indian Air Force. In the 1980s the squadron was chosen to be the IAF's first formation aerobatics team ('The Thunderbolts'), which mesmerised the country with scintillating displays. In 1992 it received the President's Colours, an event that in retirement I was able to attend, as also the squadron's Golden Jubilee a decade ago. With decommissioning of the Hunter, which the unit had flown for 37 years, the squadron was number-plated for five years before being resurrected in 2002 with the latest Sukhoi Su-30MKI.

During the Diamond Jubilee functions there were many emotional reunions. I was touched to meet up with the widow of my successor to whom I had handed over command 44 years ago. It just happened to be her birthday and the squadron had thoughtfully ensured not only a cake but also a band for the birthday music. I was privileged to be asked to help cut the magnificent Diamond Jubilee Cake, flanked by four charming ladies – wives of the present Commanding Officer, the AOC, the Commodore Commandant and my own.

In my brief address to the squadron I concluded by mentioning that, though everyone present knew that the unit was raised in 1956, only one other person present (my wife) knew that she and I had also been married in 1956! Amongst the loud cheers and popping of champagne corks, one voice called out: "Then sir, this is your second Diamond Jubilee this year!" Too true and we could not have asked for a better occasion to celebrate it again.



A No.20 Squadron Su-30MKI on exercise in the USA (photo: USAF/ A1C Ryan Crane)

No.20 Squadron was raised with de Havilland Vampires

Not many like Denny

30 August 2016 will mark the 64th anniversary of the graduation of No.58 Pilots Course of the IAF. Of those 30 young Pilot Officers who were commissioned in 1952, 15 are alive and well into their 80s. Their current dispersal has one in Goa,

with two each in Delhi, Gurgaon, Kolkata, Noida, Secunderabad, Australia and the UK. The advent of the Internet and mobile telephony helps keep these 'octopilots' in touch as course reunions have become less frequent; the bond between coursemates lasts a lifetime.

Arguably the moving spirit and stalwart of our group continues to be Denny. His good nature, cheerful attitude and popularity remain unchanged over the years. He is a fine musician and guitarist who, since 1951 has delighted his coursemates with risqué songs from an even earlier era. A gifted hockey player, he developed his leadership skills and teamwork on the sports field. He is one of our three survivors who had already served two years in the Air Force when they joined our pilots course. They were therefore not only a bit older, but more mature, knowledgeable and a source of guidance to us young Flight Cadets straight out of school and college. A more practical reason for their popularity was the fact that they continued to draw their pay (Rs 150 per month was a princely amount those days) during flying training while we direct entries had to survive on a strict 'forty bucks a month'; they were therefore the only financial source we could borrow from. Denny was always a soft touch!

Our personal friendship had its origin in two accidental events. The first was that, though two years my senior in age, we discovered that we shared a birthday. The second took place on 28 Oct 1952 when Denny and I were in the same batch who carried out our fighter conversion on Spitfire and Tempest piston-engine aircraft of WW II vintage. Each solo sortie in the (single-seat, single-engine) Tempest was shared between two pupil pilots between refueling(s). On that date Tempest HA 596 was flown by Denny who, after landing, handed over the aircraft to me on our dispersal without switching off the engine as was the briefed practice and procedure, while he helped me strap in. 15 minutes later and 3,000 feet up in the air my world literally exploded in my face as the aircraft caught fire and I was plain lucky to be able to bail out safely. Later, when we discussed the accident, Denny muttered with feeling, "A few minutes earlier and it might have been me!"

Thereafter, we had parallel careers on different air bases or units but continued to meet intermittently. I attended his marriage in Madras in 1955 and he attended mine in Secunderabad a year later. He was always a very devoted family man and our friendship is now in its 66th year. As we grew in service, he was posted to fill many important assignments in staff and command and participated in both the Indo-Pak wars actively. He has the distinction of commanding the only squadron that gave the IAF its sole Param Vir Chakra gallantry awardee. Our generation was used to a term, 'solid citizen', which described a thoroughly dependable, reliable individual both professionally and personally. Looking back over the years, there were not too many like Denny and our pilots course is fortunate to have such a solid citizen as a member.

Monkey Business

In the Air Force, the loss of a personal identity card due to negligence is viewed seriously and invites disciplinary action. The incident being related took place in 1963 when No 20 Squadron was located at Palam Air Force Station and commanded by (then) Wg Cdr David Bouche. He was a thorough professional, an extremely disciplined officer and, as his Flight Commander, I learned a great deal from him. The Boss's office was located at the end of the hangar annexe with a window behind his desk, overlooking the tarmac. One morning when he was airborne, a monkey entered through this window, spotted CO's packed breakfast lying on his table and attacked it with great enthusiasm. Halfway through, apparently bored with his repast (displaying scant appreciation for Mrs Bouche's culinary skills) it turned its attention to the Boss's uniform bush shirt hanging behind his chair. From the pocket it extracted some papers, including his identity card, which he commenced to chew! At that moment CO landed and entered his office.

Picture the scene if you will. A squadron commander enters his office to see a monkey, having demolished half his breakfast, now sitting contentedly on his table biting his identity card! The ensuing scenario and dialogue went something like this:
Boss: "ADJUTANT!"
Fg Offr 'Baby' Sehgal rushed in from next door.
"Baby can you see that monkey?"
"Yes Sir."
"It has eaten my breakfast and is in possession of my identity card. You are a witness."
"Yes Sir."
"Stop saying 'Yes Sir' and do something!"
"Yes Sir. SHAMLAL!" Our Flight Office *sevadar* came running.
When excited (and hungry) our Boss's Hindi was not as clear as he would have liked. "*Thum witness dekha? Thum monkey hai*."

Before Baby could reword that statement from the Boss, Shamlal shot off and returned with the DWO (Discipline Warrant Officer) and a posse of muscular air warriors all of whom were made witness to this gross violation of Section 65 of the Air Force Act. Meanwhile, the monkey seeing it was outnumbered, made a dignified exit through the window but took the evidence (Boss's identity card) with it.

Eventually the excitement died down and normality returned. Shamlal closed the window and produced someone's breakfast for Boss to eat in my office while I was detailed to draft an immediate letter highlighting the many witnesses to the loss of his identity card and the monkey menace that was now affecting security, flight safety and morale! Despite the absence of Witness No.1 (the monkey), a Court of Inquiry was held which exonerated the Boss from any negligence and he was provided with a new identity card. At his farewell party a year or so later, Baby Sehgal, an excellent mimic, gave a hilarious rendition of the incident, news of which had spread rapidly on the informal (but effective) Air Force grapevine. On my last visit to London a few months ago, I called up Air Cmde Bouche, now in his late 80s, to pay my respects. As usual, he always asked me about 'our old squadron.' I updated him as much as possible and assured him that the squadron was now located at a base with no monkeys! He laughed heartily.

Post Script: This story has been told and retold frequently with non-witness anecdotalists tending to add a little tale-spin each time. I must therefore warn the reader to treat with great caution a latest version on the internet which claims that the Palam monkey had been subsequently caught, detained in the Air Force museum and has recently been spotted in Gurugram. At worst this is an outright canard and at best, a case of mistaken identity!

25 Years Back

From Vayu Aerospace Review Issue V/1991

Storm Warning !

Disintegration of the Soviet Union into smaller, independent, states has been a haunting nightmare for the Indian armed forces, the bulk of whose heavy weaponry, armoured forces, combat aircraft, missiles and warships are of Soviet-origin. The Indian Air Force inventory, including building under-licence in India, has been in the vicinity of 2000 combat aircraft, transports and helicopters of which over 1100 remain in front-line service, not to mention the thousands of air-to-air missiles, air-to-ground and surface-to-air missiles plus infrastructure.

Supplies of spares and replacement equipment has been drying up for well over a year but the dramatic developments in August 1991 have to all intents and purposes created a totally new situation, one which could not have come at a worse time for India, already reeling under a foreign exchange crunch of unprecedented magnitude.

US War Games and India

General Dynamics of the United States, whose Tomahawk cruise missiles were employed with extreme accuracy during operation 'Desert Storm' early in 1991, have reportedly commissioned a mock war scenario targeting India with 307 US missile attacks to prevent this country's plans for any nuclear strike against Pakistan. The Exercise had caused serious concern in India and General Dynamics, one of the largest US arms manufacturing companies, has now promised to "remove this scenario from all future presentations."

Boeing 777 Presentation

On heels of the Boeing 747-400 sale to Air India, the Seattle-based company has offered the new Boeing 777 of this country. Boeing's regional director, Asia-Pacific 777 Marketing Management, said that "777 will be the pace setter for the next century. It is a path breaking effort in aviation technology. He said the Boeing 777 was designed with inputs from the world's leading airlines including Air India and has the "broadest possible market appeal".

HAL-Dornier 228s for the Indian Navy

The first HAL-built Dornier 228-201 aircraft for the Indian Navy was formally handed over to the Service at HAL's Kanpur Division on 24 August 1991. The Dornier 228 was thereafter flown to Palam airport (Delhi) for a brief presentation to the Deputy Chief of Naval Staff and thereafter to Dabolim (Goa) on the 26 August 1991. Ceremonially escorting the Dornier 228 before landing at the Naval Air Station INS *Hansa* was an Alize of INAS 310 ('Cobras'), the French-built MR/ASW aircraft which now retires from the Indian Navy after 30 years of operational service.

Defence Debate 1991

India's Defence Minister Sharad Pawar has said India had never wanted a war with Pakistan but it would not hesitate before giving Pakistan a "befitting reply" in case of an attack. Warning Pakistan to immediately stop armed instructions into Indian territory and cease all assistance to terrorists, Pawar said not a single day passed without firing by Pakistan along the Kashmir border. Mr Pawar said that the Soviet Union has assured full cooperation in India's defence preparedness despite internal developments. "We have very good relations with the USSR and are confident of carrying them beyond 1995 when the present treaty expires". He also said that India was trying to seek cooperation from the United States in the field of defence as part of "its strategy of friendship with all". Pawar said the government had so far spent Rs 174 crore on the Main Battle Tank (Arjun) project and Rs 375 crore on the Light Combat Aircraft. Both were undergoing trials and "shortcomings were being rectified".

Vayudoot Re-structuring

The civil aviation ministry, having decided against folding up of Vayudoot now proposes to revamp the feeder airline to make it viable. The proposal includes induction of new aircraft, retirement of eight HAL-HS 748s, reduction of staff through a "golden hand shake scheme" and/or the transfer of some to Indian Airlines and Air India, and the restructuring of routes to ensure optimal utilisation of aircraft.

More F-7Ps for the PAF

The Pakistan Air Force is to receive an additional batch of 40 F-7P fighter aircraft from China. Pakistan's air defence planners had pinned their hopes on the second package of 60 F-16s from the United States, which General Dynamics was to supply to Pakistan under an agreement signed between Pakistan and United States but following enactment of the Pressler Amedment, the US administration has not only stopped the supply of new F-16s, but also withheld the provision of spare parts for the fleet of F-16s already in service with the PAF.

Chinese fighters for Sri Lanka

The Sri Lankan Air Force have received two Chengdu FT-5 operational conversion trainers in anticipation of a larger batch to Xian F-7M fighters, expected later in the year. The Chinese-fighters will be formed into No.5 Squadron and based at Katunayake airport.

China receives Sukhoi Su-27s

The Chinese Air Force has received the first, small, quantity of Sukhoi Su-27 long-range air superiority fighters from the Soviet Union. Reportedly eight Su-27s were in the first batch, there are being stationed on Hainan Island, and will undoubtedly be followed by larger quantities in the period ahead.

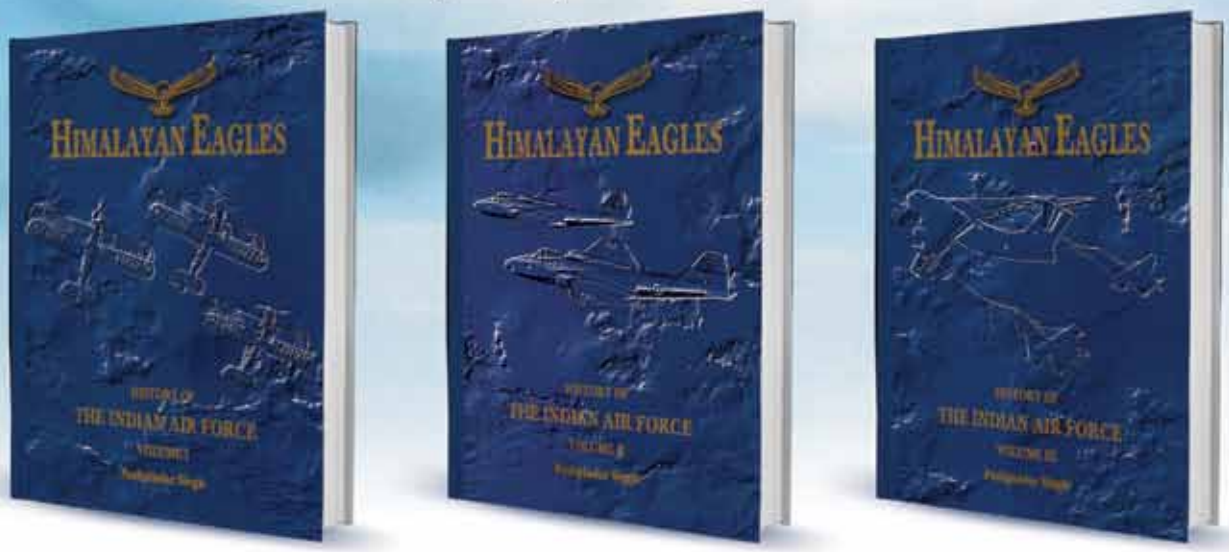
Luftwaffe Alpha Jets withdrawn

In drastic restructuring of the Luftwaffe, three Wings of Alpha Jets are being disbanded, together with two RF-4E Wings. The Alpha Jets will be transferred to Portugal (with Turkey and Greece also mentioned as possible recipients). Around 20 Alpha Jets will be retained by the German AF for advanced jet training.

THE IAF's HISTORY ENSHRINED

HIMALAYAN EAGLES

by Pushpindar Singh



Volume I
Foundation

Volume II
Consolidation and Expansion

Volume III
World Air Power

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by Pushpindar Singh

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- Tusker Charge
- When Lightnings Strike
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- Black Archers
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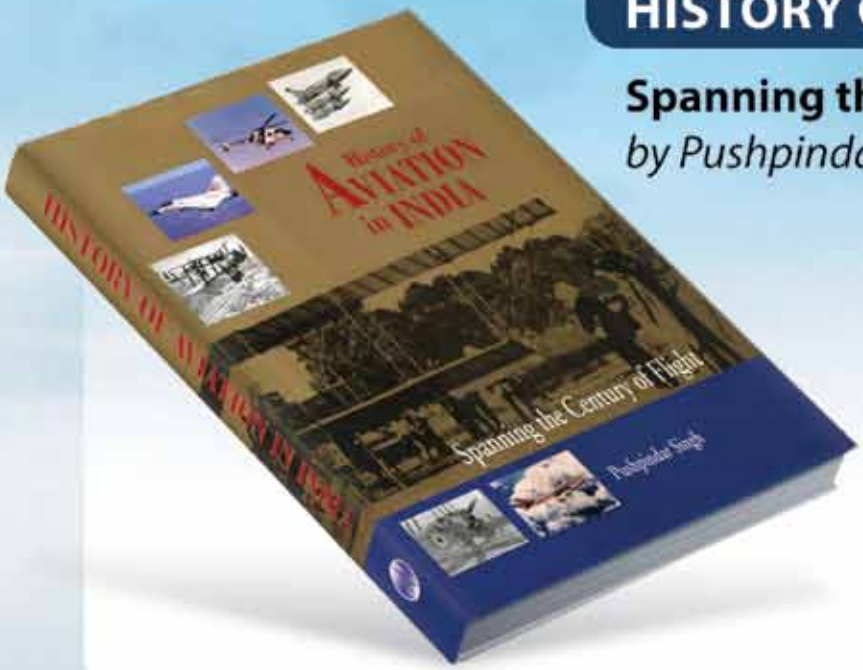
HISTORY OF AVIATION IN INDIA



Spanning the Century of Flight

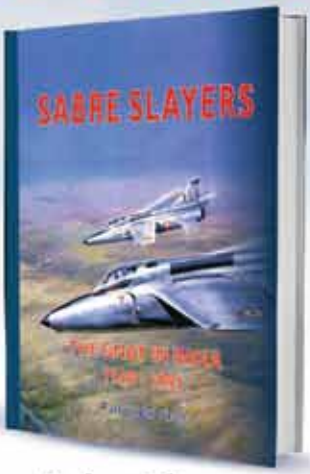
by Pushpindar Singh

This unique publication presents much fascinating history, with facts and figures embellished with a feast of images, near 500 of them, many rare and hitherto unpublished. The *History of Aviation in India* is a veritable treasure trove of aeronautical history that will assuredly become both the air enthusiast's and aviation professional's book of reference as the world continues on the second century of flight.

All time Classics!

Spirits of the Wind

by Pushpindar Singh



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Tale Spin

Wannabe !

Caption to the above picture appearing in Air India's inflight magazine 'Shubh Yatra', of August 2016 :

Tejas, the light combat aircraft (LCA) and India's first indigenous fourth-generation fighter plane, was recently inducted into the Indian Air Force. (Photograph is actually of Swedish, Czech and Hungarian Gripens in formation).

Tejas to ADA : "When I grow up, I wannabe Gripen !"

(Red) Indian Air Force

Considering the new inductions being made, the Indian Air Force might well soon be described as 'Red Indian', what with Chinooks and Apaches joining the Force from North America.
"How the West was won".

More seriously, strategic observers opine that "today, everything from aircraft carriers to fighters to UAVs is on the table as Washington seeks to expand defence ties with New Delhi and the heavy lift/attack helicopters are just a tip of the iceberg"…. or the prairies ?

Thank you Tejas LCA !

Advertisement in all leading news papers of India.

Being late is no excuse !

Tejas on Wheels

Its catchy ! The Railway Ministry, inspired no doubt by the LCA, has named its brand new train service as 'Tejas', with fares some 30% more than the premier Shatabdi Express but having commercial airline-like services including call bell buttons and LCD screens on ergonomically designed seats, wi-fi facilities … the coaches will have exotic exterior paint with a rising son motif against golden sands… Dream on !

Howler One

The Maharashtra Government will honour a young pilot who is building "India's first aeroplane, a 20-seater commercial aircraft at that". The prototype of a 6-seater aeroplane has been built on the terrace of his flat in Charkop, Mumbai, and will fly soon ! "Maharashtra and India could be on the world aviation map once he starts manufacturing these aircraft" said a Government official who didn't wish to be identified.

No wonder !

Howler Two

A BSF jawan on the J&K border raised an alarm after an alleged air space violation, the IAF immediately being informed of the location and flight path. The aircraft was described as being "with six wings".

One knows of the Red Baron's three winged Fokker tri-plane, so this must have been a hexa-plane. The jawan has either super sensory vision or must visit the nearest Ophthalmologist !

Afterburner

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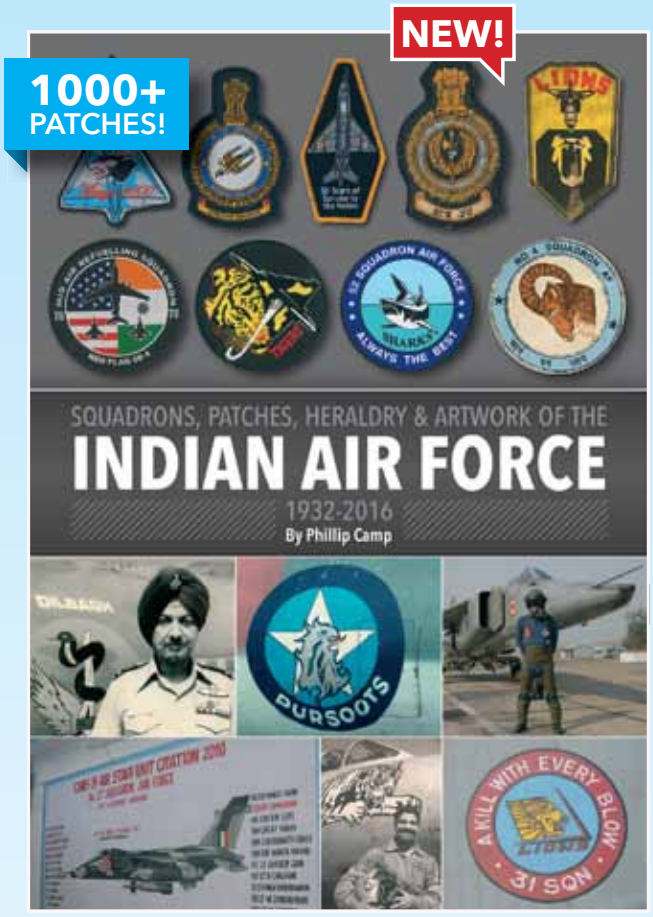

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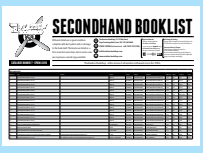

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