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Tejas LCA Mk.I at Aero India (photo by Deb Rana)

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COMMENTARY

Half-term report card

The military has started 2017 with a fresh slate on several fronts. The Army and the Air Force both have new Chiefs, an opportunity for fresh ideas and approaches. There is hope that the military could soon get its first Tri-service commander, creating badly needed synergy between the Army, Navy and Air Force. Across the border, Pakistan too has a new Army Chief, who seems less inclined to grandstand, and appears to understand that tensions with India distract his military from more urgent priorities. Looking further out, as a new US President, Donald Trump, outlines his policies towards Russia and China, New Delhi will have to tack to new headwinds from that Great Power triangle.

The BJP manifesto had promised specific measures to strengthen external defence. The important ones included: (a) Reforming defence equipment procurement, support services and organisational functioning; (b) Modernising the armed forces by fast-tracking defence procurement; and increasing research and development spending to develop indigenous technologies; (c) Addressing manpower shortages (which actually exist only at the officer level), including by making Short Service Commission more attractive; (d) Ensuring the military plays a larger role in defence ministry decision making; (e) Dealing firmly with cross-border terrorism, including by improved border management; (f) Improving military justice, by reforming Armed Forces Tribunals (AFTs) and minimising government appeals against adverse court verdicts.

The long-delayed Defence Procurement Policy of 2016 (DPP-2016) has some innovation, such as the preferential procurement category of 'Indian Designed, Developed and Manufactured', which would distinguish truly 'Made in India' equipment from kit that actually has a foreign address to its intellectual property. Yet, DPP-2016 is by no means the crisp, result-oriented handbook that Parrikar wanted to liberate procurement from cumbersome, dead-end procedure. Instead DPP-2016, like its predecessors from 2005, 2006, 2008, 2009, 2011 and 2013, remains a weightlifter's tool and a bureaucrat's delight, filled with opportunities for delaying the acquisition of vitally needed equipment.

Instead of ramming through change like the go-getter he is, Parrikar has tied his own hands by placing reform at the mercy of numerous committees. First, the Dhirendra Singh Committee, headed by a former government secretary, produced a 264-page report on defence procurement reform, including Mr Modi's slogan-of-the-moment, 'Make in India'. Then, to implement the Committee's central recommendation on nominating private sector 'Strategic Partners' (SPs), who would be the automatic, go-to manufacturers in their various fields (aircraft, helicopters, warships, armoured vehicles, etc), the VK Aatre Task Force was set up. To this day, not a single SP has been created, even as foreign aerospace vendors like Boeing and Saab wait bewildered, wondering when they will know which Indian company would be nominated as SP for manufacturing aircraft in India. Instead, every project goes through a complex tendering process that inevitably means indefinite delay.

Ajai Shukla, in Business Standard

The New Chief

The announcement of military chiefs in India has usually been an unremarkable, ritualistic affair, with the name of the senior-most eligible candidate being announced about two months prior to the changeover. With the announcement of Lt General Bipin Rawat as the incoming Army Chief to replace General Dalbir Singh, however, the NDA government has disrupted things-as-usual by dispensing with the long-standing noun of seniority. According to reports, the government's argument is that it chose the most suitable officer based on various aspects of the security situation in the country and the future scenario. In the current security situation, counter-terrorism and counterinsurgency are the key issues and the government arguably felt that Lt General Rawat is best suited for the position by virtue of his operational assignments. The decision has sparked controversy — for one, it is being pointed out that the role of the Army Chief is not of an operational nature, it deals with the strategic management of national security at the highest level. Hence, there is need for the government to communicate more openly and clearly the reasons for its decision.

Having said that, it must be reiterated that the political leadership has the final prerogative of selecting the Army Chief. That is essential to maintaining the delicate balance of civil-military relations in a constitutional democracy. Seniority cannot be the sole criterion for selecting a military chief. But the alternative to choosing by seniority cannot be an opaque, arbitrary selection made by the political leadership. The government should formulate an institutionalised process which delineates the selection criteria clearly, so that not only is the selection fair, it is also seen to be fair. This would require of the political leadership a greater engagement with the military. There is an inherent risk of political interference in such a case, but that is the only way ahead for a more transparent and professional selection process.

The incoming Chief inherits a challenging environment on the national security front. The ceasefire on the Line of Control is being followed more in its breach and the level and intensity of violence has gone up in the Kashmir Valley this year. Closer cooperation between China and Pakistan, especially on the military front, is another cause of worry as a new army chief has assumed office in Rawalpindi. Internally, there have been voices of discontent in the army over the pay commission, inter-se seniority with civilian officials and the one rank-one pension issue. General Rawat will have to hit the ground running to take these things in his stride.

From *The Indian Express*

Take the Call

In a significant reform for the armed services, Defence Minister Manohar Parrikar is expected to meet Prime Minister Narendra Modi soon to discuss the mandate and appointment of a Chief of Defence Staff (CDS). The CDS will be a unifying force for all the three Services and serve as a single-point military adviser to the political leadership.

This comes after the government decided to supersede two senior generals to appoint General Bipin Rawat as the next army chief on the basis of operational requirements. The appointment of a CDS will show the government is committed to streamlining the armed forces.

The idea of a CDS for the armed forces has been doing the rounds for many years now. It was recommended by a group of ministers way back in 2001. In that sense, the appointment of a CDS needs to be seen in the context of creating joint commands to optimise coordination among the three services. Reasons why a CDS had not been appointed so far include the turf war culture within the armed forces and the old fear of a military takeover. Needless to say, these need to be overcome keeping in mind operational requirements of the armed forces and security challenges the country faces.

This is also why the mandate of a CDS needs to be clearly defined. The post can't be a parking slot for overlooked generals and should be a genuine tri-service command that operationally integrates the various defence branches. This is the direction in which most modern militaries have evolved, as exemplified by the US armed forces. Better integration would additionally help establish a desirable teeth-to-tail ratio within the armed forces by cutting flab. Taken together, the appointment of a CDS is imperative and can't be ignored any longer.

From *The Times of India*

Arms and alarm bells

The United States President Donald Trump, has a predilection for the off-the-cuff statement. This, in turn, has spawned a micro-industry of interpretation, commentary and, finally, spin doctoring by members of Trump's staff. Trump recently weighed in on the nuclear weapons policy with a warning that he would launch an "arms race" if needed to maintain US supremacy. Unsurprisingly, this has rung alarm bells because it would indicate a desire to overturn over three decades of consensus that fewer warheads are better. For the most part, however, Trump's comments and the subsequent explanations by his staff have only caused confusion and concern that the world's most powerful man announces policy as if he was on reality television.

Trump has no grounds for worrying about the credibility of the US's nuclear deterrence. Though its warhead count is almost unchanged since 1967, a comprehensive review in 2013 by the US military concluded that if anything the US had about a third more warheads than it needed. Trump's own Pentagon chief pick, is among those who have in James Matis past have said that the US can reduce its nuclear arsenal. The Barack Obama administration did conclude that the delivery, safety and technical aspects of the arsenal needed an upgrade, and sanctioned a one trillion dollar modernisation programme that is still unfolding. Russia has also focussed on upgrading its missiles. The only area it can be argued there is an "arms race" is in the area of ballistic missile defence, where both countries have kept building better interceptors as well as weapons designed to avoid the same.

Trump has already outlined aggressive plans to expand the size of the US military, especially in terms of infantry and warships. More importantly, the entire theme of his election campaign and the narrative surrounding his policies is about "making America great again" and maintaining US supremacy on all counts. This seems to combine with his seeming inability to understand that even his whimsical comments are treated as official policy.

From *Hindustan Times*

Domestic firepower

Whether a "live" demonstration of the Army's firepower will serve as the requisite incentive is a matter for debate, the importance of the proposed "Shows" at the Artillery School and Centre and the Infantry School is that they seek to involve leaders of the academic fraternity in the design and development of hi-tech indigenous weaponry. They serve as one step beyond dovetailing private industry into the defence production effort. Hopefully, the initiative of the still-fledgling *Army Design Bureau* will facilitate a pooling of various talents that will, eventually, lead to India becoming a major arms producer: a more welcome "tag" than being one of the world's largest importers of military hardware.

Though the story of Indian-made weaponry began centuries ago, it failed to keep itself abreast of technology development – as exemplified by the producers of the 'zamzamah', made famous in Kipling's 'Kim', being reduced to having to import howitzers resulting in a scandal that persists for over two decades. According to some reports, the Army has identified as many as 170 "problem areas" in its modernisation drive, and the induction of "grey matter" into the remedial effort needs a degree of appreciation. It is not a happy reflection on the functioning of the Ordnance Factory Board and its 40-odd factories that a deficit of "brain-power" is felt. For far too long the OFB and the public sector undertakings of the defence ministry have operated under monopolistic conditions, there has been internal stagnation and the limited induction of technology has been linked with licenced production in India of equipment of imported design. The Army and the Air Force have traditionally been quite happy with "got-abroad goodies" – in contrast with the Navy that has had its own design bureau for several years, with the result that a fair number of home-built war ships now traverse the seven seas.

Import-substitution and self-reliance have not been "pushed" hard enough in the other Services, hence applause is due to the efforts of the Army Design Bureau. It will, however, take more than a design bureau to ensure that 'Make in India' becomes more than a slogan as far as defence production goes. It was recently admitted that a decision on a second production-line for fighter aircraft (in addition to the state-run Hindustan Aeronautics Ltd) was being stalled because no policy had been formally approved for the manufacture of fighters in the private sector. There is clearly need for a 'mission mode' to be adopted to address identified shortages in the armed services. The soldiers, sailors and airmen deserve the best equipment the nation can afford to provide them, they will not quibble over who produces it. Will a separate Ministry for Defence Production prove the spur?

From *The Statesman*

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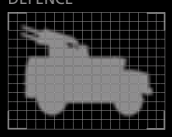

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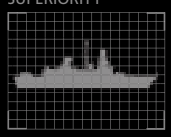

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Ajai Shukla charts out tough choices for the IAF

Light, medium or heavy fighters?

On the cusp of his retirement, Indian Air Force CAS, Air Chief Marshal Arup Raha, had stated that the IAF requires about 200-250 medium fighters in addition to the 36 Rafale multi-role fighters that were contracted with French vendor Dassault in 2016. Value of that contract was € 7.8 billion (Rs 55,600 crore), so another 200 Rafales, or comparable fighters, would require an estimated € 43.3 billion (Rs 310,000 crore), which is far beyond India's means, given current defence spending.

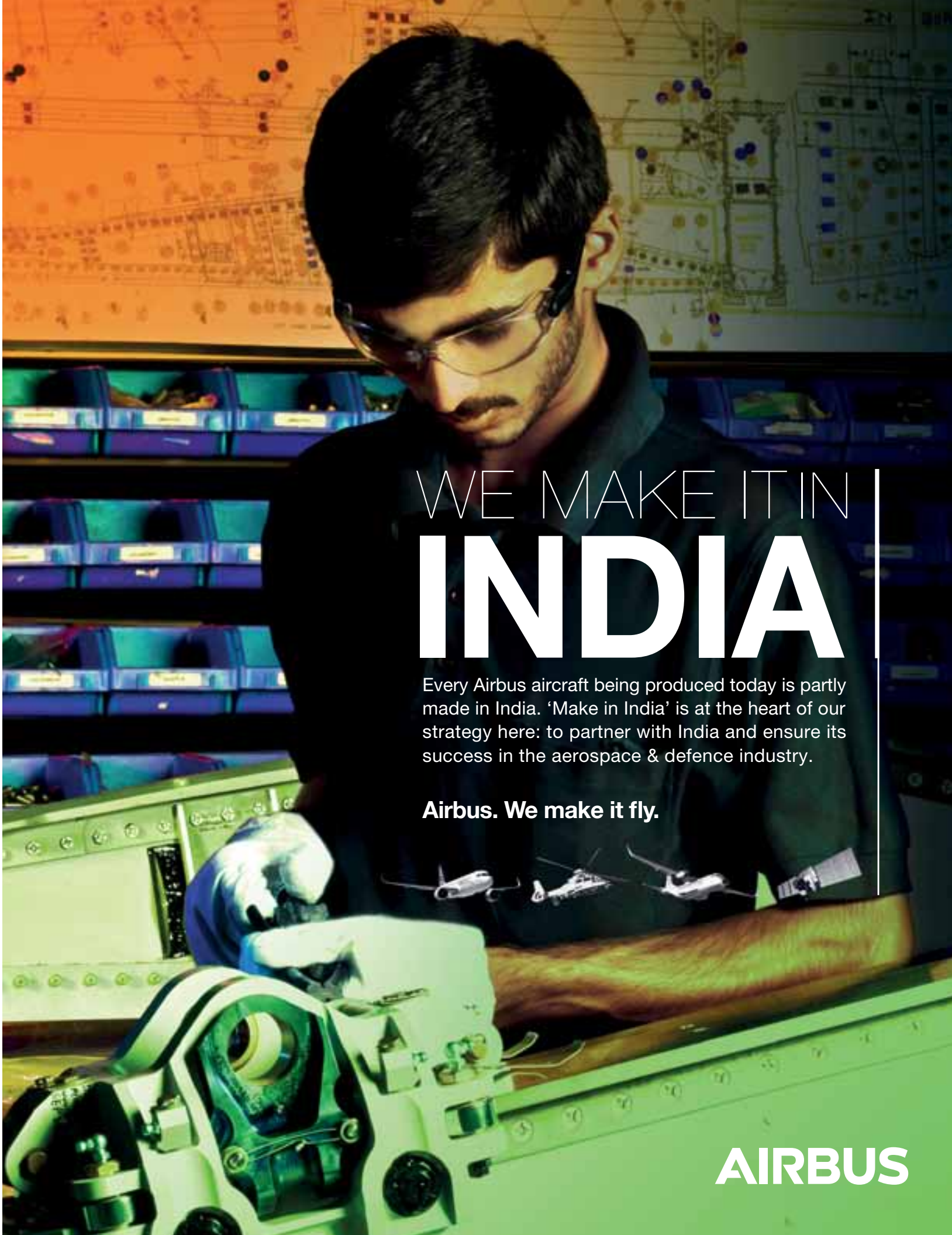
But Raha did not hesitate to put the IAF's requirement on the table. "We have just ordered 36 Rafales and we require more aircraft in the medium weight category to give [the IAF] an entire spectrum of capability," he said. The IAF currently operates just 33 fighter squadrons against an assessed requirement of 42 squadrons needed to face China and Pakistan jointly. Of these, 11 squadrons of MiG-21 and MiG-27s are operationally suspect, being long overdue for retirement. Referring to this, Raha stated: "We have already used them for four decades plus. It is time to retire them and get new aircraft… Over the next 10 years, we must have 200-250 aircraft. It has to be balanced out. In the heavy weight spectrum, we have enough. But in the medium weight category, we need to have more. Yes, about 200 will be very good".

An analysis of the IAF's present 'force mix' reveals that the shortfall in fighters is actually in the 'light' fighter segment, not in 'medium' fighters. By 2022, when 11 squadrons of MiG-21s and MiG-27s would have to be phased out, there would be a dire shortfall of such equivalent weight fighters. At best, a limited number of Tejas LCAs would have come in, leaving that segment with just a few squadrons. In contrast, there would remain 12 squadrons of legacy fighters (Jaguar, Mirage 2000, MiG-29) in the medium fighter segment plus a hefty 14 squadrons of Su-30MKI (heavy) fighters.

As reputed aviation analysts have opined "The IAF's needs to immediately replace 11 squadrons of obsolescent MiGs. Their replacement, therefore, must be affordable to-buy and operate light-to-medium fighters. Since we cannot afford 200 Rafale-class fighters, and the Tejas production line is evolving too slowly, the IAF is left with just one option: setting up a second production line to build fighters of this class in large numbers for the IAF".

The government is actually moving down that path. On 7 October 2016, the IAF reportedly contacted several global aerospace giants, including Lockheed-Martin, Boeing, Saab and Russia's Rosoboronexport, soliciting interest in setting up a production line in India to build single-engine, medium fighters. US firm Lockheed Martin, which is offering the F-16 Block 70 and Saab, which is introducing their new fighter, the Gripen E, are the current front runners, both being marketed aggressively in New Delhi.

Over the last 15 years, the IAF has been framing its fighter aircraft requirements in terms of light, medium and heavy fighters. About the year 2000, Air Headquarters stated that an ideal "force mix" would be 200 fighters each in the light, medium and heavy categories. The rationale for this was never made clear. Traditionally an air force's 'force mix' has been based on aircraft roles, not their weight nor size.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Professional Air Forces have projected their need for 'air superiority fighters' that shoot down enemy aircraft to gain ascendency in the air; 'strike aircraft' to destroy enemy targets, including airfields, lines of communication and even strategic assets; and 'close air support fighters' that strike at the enemy in the tactical battle area as also carry out battlefield interdiction to paralyse different components of the enemy's fighting machine from functioning together. Separately are included the need for specialist aircraft for tactical and strategic reconnaissance and electronic warfare.

The world's most powerful air arm, the US Air Force, has super-specialist aircraft for each role. Their F-22 Raptors and F-15 Eagles presently perform the air superiority role; while the strike efforts fall to the F-15E, F-16, A-10 and increasingly the F-35 Lightning II Joint Strike Fighter (JSF). The US Navy have separate fighter aircraft for combat operations off aircraft carriers: the F/A-18E/F Super Hornet, which operates in tandem with an electronic warfare fighter variant, the F/A-18G Growler. The Navy version of the JSF will be the F-35C.

Smaller (and lower-budget) Air Forces increasingly use multirole fighters that are capable of performing most roles, albeit slightly less proficiently than specialist aircraft. Modern systems allow pilots to switch from one role to another, with higher weapons payloads which allow such aircraft to carry both air-to-air missiles as well as surface attack bombs. In this category are various 4+ generation multi-role combat aircraft such as the Rafale, Typhoon, F-16 and Gripen, all these types (as also the MiG-35 and F-18) having been thoroughly evaluated by the IAF during the MMRCA evaluation years.

What does this mean in practical terms? In earlier days, a 'mission package', say for striking an oil refinery deep inside enemy territory might have required nine aircraft: four ground strike aircraft, another four air superiority fighters to protect them en route from enemy fighters, as well as an electronic warfare aircraft to jam enemy radars on the way. Now, with multirole aircraft carrying bombs, missiles as well as jammers, four to six multi-role fighters could target the refinery, tackle enemy fighters and jam radars en route.

However, also uniquely needed are 'force multipliers' such as mid-air refuellers and airborne early warning and control system (AWACS) aircraft. These facilitate rapid turnaround of fighters, and greater airspace awareness, allowing air forces to do more with perhaps fewer fighters. While a Sukhoi-30MKI can do a three-and-a-half hour mission on internal fuel, its mission time can be vastly extended with air-to-air refuelling.

The IAF is slowly transitioning from mission-specific to multirole fighters. Only the Mirage 2000 in its present inventory can be considered as being 'multirole'. The bulk of its obsolescent MiG-21s are essentially air superiority fighters, except for the MiG-21bison, which has been upgraded with some multirole capability. The MiG-27 is a pure ground strike fighter, as is the Jaguar, although the latter has some inherent air defence capability. The MiG-29 was designed as an air superiority fighter, the on-going upgrade is providing it with some strike prowess, giving it some multirole capability for what remains of its service life. As for the Sukhoi Su-30MKI, this large and heavy fighter has great endurance but is essentially employed for 'air dominance' although it can carry a formidable bomb loads over long distances. Long in coming and still very short of numbers is the Tejas LCA, the first squadron of which is presently being stood up but the follow on Mk.IA is still some time away from induction.

With seven types of fighters already in the IAF's inventory (five types after the MiG-21 and MiG-27 retire), the Indian Air Force's most pressing concern in a future conflict would be the nightmare of maintaining and supporting all these different aircraft types.

Nor has there been a hardnosed reassessment of how many combat squadrons the IAF really needs. The figure of 42 squadrons was arrived at many years ago, but has not been revised after the advent of high-performance, multi-role aircraft supported by a range of force multipliers. Given the cost of modern fighters and the existing pressures on India's defence allocations, this issue will inevitably be revisited in the future.

With extracts from the Business Standard

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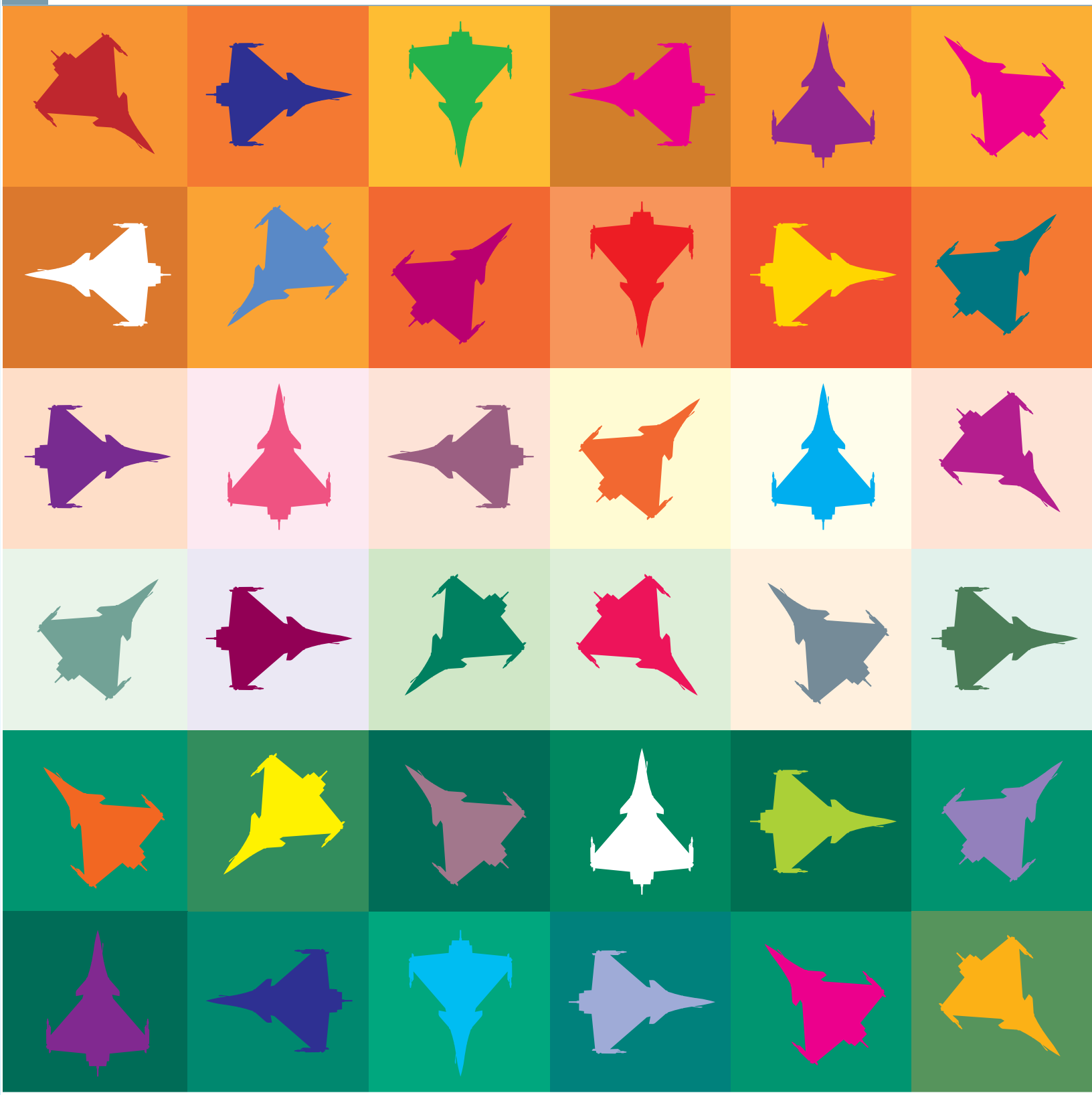

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OPINION

Agenda for General Rawat

Highest priority for the new Indian COAS must be to address the critical hollowness in the Indian Army's operational preparedness, opines Brigadier Gurmeet Kanwal (retd).

As the head of perhaps the most potent instrument of the national will, a combat force that has held the nation together through many wars and insurgencies, General Bipin Rawat, the new Army Chief, has his work cut out. There must be synergy between the new COAS and the government to successfully defeat Pakistan's war against India through asymmetric means, manage periodic tensions on the Line of Actual Control with China and to continue to undertake effective counter-insurgency operations in Jammu and Kashmir and the North-Eastern states.

Surgical strikes across the Line of Control and counter-insurgency operations in J&K took centre stage during the year gone by and engaged the attention of the nation and the Army's top brass. However, it is operational preparedness and the improvement of the army's combat effectiveness that should be the highest priorities for General Rawat.

Next in order of priority should be the modernisation of the force, the development of infrastructure, improvement in training standards and the resolution of organisational issues, including human resources management and the welfare of personnel. In March 2012, General VK Singh, then the COAS, had written to the Prime Minister about 'critical hollowness' in the Army's operational preparedness. He had pointed out large-scale deficiencies in weapons systems, ammunition and equipment in service in the Army and the fact that many of the weapons and equipment were obsolete or bordering on obsolescence. In particular, he had brought out that the artillery and air defence arms needed the infusion of modern guns, missiles and radars and the aviation corps required new helicopters to replace the ageing fleet.

The infantry was sorely in need of a replacement for the 7.62 mm basic rifle in use. Two consecutive reports of the Comptroller and Auditor General of December 2011 and November 2012 brought out that the state of defence preparedness was a cause for serious concern. The Standing Committee on Defence in Parliament has also noted these developments with concern several times.

In an unprecedented move, the Standing Committee on Defence insisted on meeting the three Chiefs to take stock of operational preparedness. The Standing Committee on Defence has repeatedly urged the government to increase the defence budget to enable the armed forces to undertake meaningful modernisation.

Weapons, ammunition and equipment shortages have persisted for long and several Army Chiefs have written to the PM and the Defence Minister for help to make up the shortfall. During the Kargil conflict in 1999, the nation had heard General VP Malik, the then COAS, make the chilling statement on national TV, "We will fight with what we have."

Though the conflict was confined to Kargil district, 50,000 rounds of artillery ammunition had to be imported as an emergency measure because the stock holding was extremely low. If it had become necessary to open another front, the shortage of artillery ammunition would have seriously hampered operational planning.

Military modernisation has two major facets: the replacement of obsolete and obsolescent weapons and equipment with modern ones, which results in increasing combat effectiveness; and the qualitative upgradation of combat capabilities through the acquisition and induction of force multipliers.

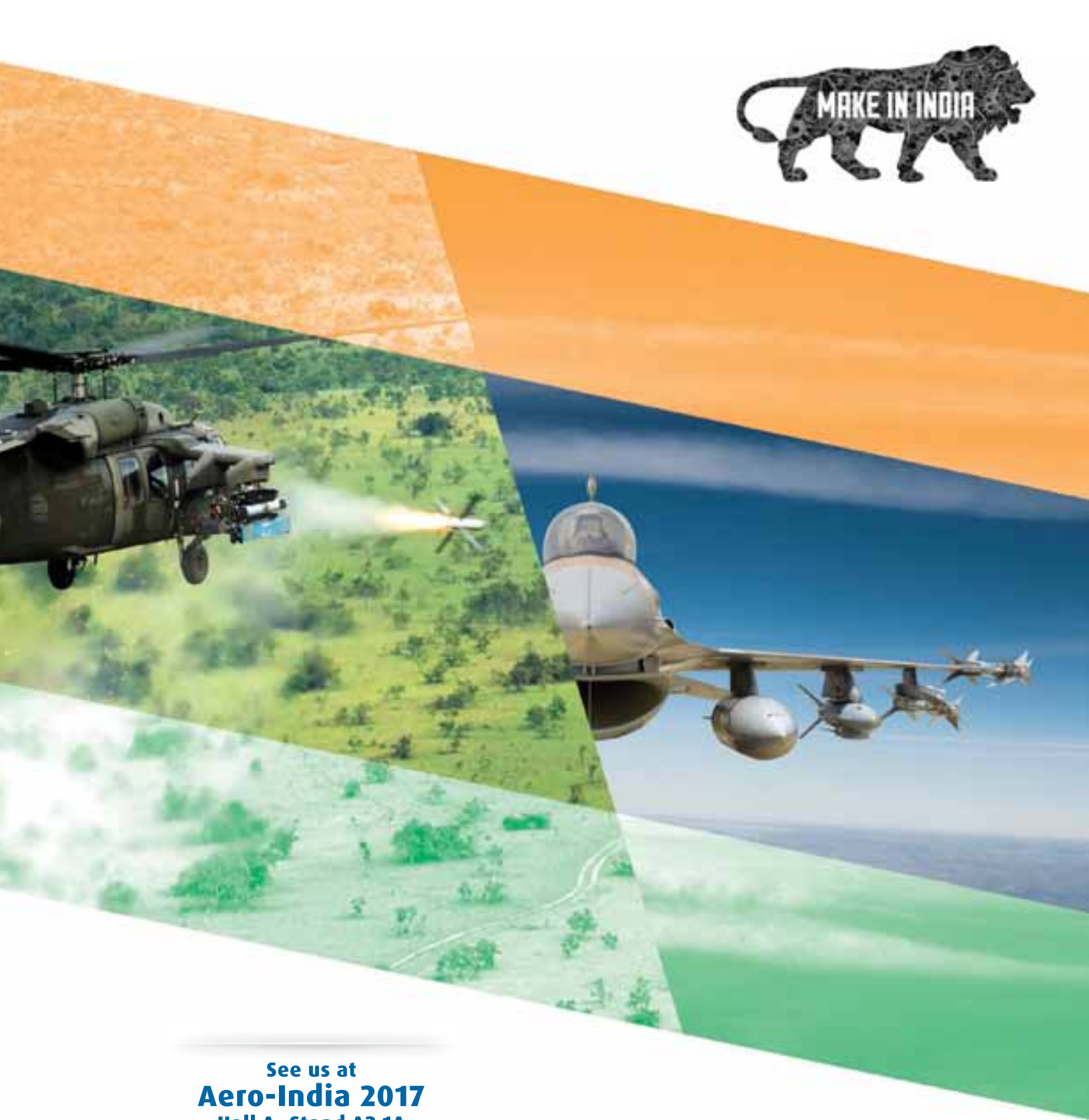
General Rawat, like his predecessors, faces a major dilemma: how should a meagre budget be parcelled between improving operational preparedness while simultaneously making concerted efforts to modernise, especially the induction of force multipliers like state-of-the-art intelligence, surveillance and reconnaissance systems?

Logically, operational preparedness should take precedence over modernisation. The art of military leadership lies in finding an optimum balance so that all efforts that are made to enhance operational preparedness also contribute substantively to modernisation. The new COAS will preside over the transformation of the Army to a 'network centric' force capable of executing 'effects-based operations' over the full spectrum of conflict.

General Rawat must forge a light, lethal and wired force that can fight and win India's wars on the battlefields of the 21st century – jointly with the Navy and the Air Force. The Transformation Study undertaken by Army Headquarters in 2009 will provide good pointers to the shortfalls in cutting edge operational requirements and the measures necessary to overcome these. For example, the Army must improve its rapid reaction capability.

Ahead of his time as he was, General K Sundarji had nominated the 54th Infantry Division as an Air Assault Division preceding *Exercise Brass Tacks IV* in 1987. Thirty years later, the Army still does not have a dedicated air assault division. Now, of course, it needs at least two such divisions– both for conventional conflict and intervention operations. The 'teeth-to-tail' ratio needs substantial improvement. There is a requirement to reduce the costs incurred on manpower without cutting manpower itself; for example, by outsourcing routine maintenance assignments to trade. The logistics chain must be streamlined to provide just-in-time logistics, rather than being dependent on numerous depots with huge inventories.

And, finally, the new COAS must pay attention to improving the welfare of the troops under his command, including improvement in combat gear, better rations and accommodation. He must spend time resolving personnel issues, such as the grievances regarding pay and allowances, which have been sapping morale. Civil-military relations have not been good in the recent past and the Chief must work with civilian counterparts to improve relations by an order of magnitude. No Army in the world can be effective if it does not have the unqualified support of the civilian leadership and the bureaucracy.



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Indian Defence Minister on "Strategic Partnerships and 'Make in India' fighters"

On 3 January 2017, Defence Minister Manohar Parrikar confirmed that a new production line for single-engine fighters – over and above existing HAL Tejas LCA production – will be started in India under the long-awaited Strategic Partnership model of the Defence Procurement Procedures (DPP) 2016. "A second line of single engine *[fighters]* is also required for which we are looking at the strategic partner route and very soon, once the strategic partner chapter is finalised, we should start moving in that direction. During the current year the decision should be tentatively over *[sic]*. Maybe a few of them will come in ready-made status *[i.e. flyaway from the OEM]* but the rest will be made in India," stated the Defence Minister.

Mr Parrikar said that while the Indian strategic partner for the single engine fighter would be identified through the Aatre Committee model, selection of the Western partner would depend on the Transfer of Technology (ToT) offered and the financial proposal of the OEM. "Competitive process will be followed," stated the Defence Minister, although the deal would be finalised under a Government-to-Government (G2G) process.

Since the DPP chapter on Strategic Partnerships (the Aatre Committee model referenced above) is crucial to this plan, the Defence Minister stated that discussions on this chapter were in the "final stages" and were likely to be concluded by the end of January 2017.

Referring to on-going production of the indigenous Tejas Light Combat Aircraft (LCA) at Hindustan Aeronautics, Parrikar pointed out that "Tejas has already been inducted and one line for eight aircraft per year is already operational in HAL." However, notwithstanding the available infrastructure at HAL to assemble Tejas LCAs, the DPSU has delivered only thee 'Series Production' aircraft in two years (2015-16), and is not expected to exceed 4-5 deliveries in the 2017 calendar year. However, Parrikar added: "HAL is gearing up to increase it [capacity] to 12 [per year]. Recently, we have taken up a final stage approval for enhancing production capacity to 16."

Mr Parrikar also said that an option to pursue development of the Tejas Mk.2, an advanced version of the LCA, "has been kept open." He did, however, confirm the Navy Chief's assertion that the Naval LCA is "not suitable" for employment aboard aircraft carriers, and will be "developed only for technology demonstration" henceforth.

The Defence Minister dismissed reports that India was considering further direct procurement of additional Dassault Rafale fighters, to supplement the 36 already on order. This clarification came shortly after the former Air Chief, recently retired ACM Arup Raha, said in December 2016 that 36 Rafales were "not enough" and more aircraft were needed in the "medium weight" category. Raha had also said that India needs at least 200 more fighter aircraft over the next ten years.

In a surprise revelation, however, the Defence Minister stated that a *second* competition – albeit for twin-engine fighters – would also be considered by the MoD, but not until the single-engine procurement was decided. It is expected that this programme will not see any significant movement before the 2018-19 period, and will include for consideration *all* global options available at that time. On the other twin-engine/fifth-generation project in the offing – the Indo-Russian Fifth Generation Fighter Aircraft (FGFA) – the Minister sounded a diffident note, stating that "aspects of production and technology transfer are being looked into" before signing up for further development and eventual production of the type.

'Strategic Partners' yet to be identified

The Defence Ministry's 'Make in India' programme has reportedly run into some turbulence with the MoD unable to finalise the 'strategic partners' (SP) model. This involves identification of private Indian companies for in-country manufacturing of defence hardware. The three critical projects requiring urgent decision are the Indian Navy's Project 75(I) for construction of conventional submarines, manufacturing of naval helicopters, and new single-engine fighters for the IAF.

The SP model was first proposed by the Dhirendra Singh Committee in July 2015, which envisaged identifying a private Indian company for assured contracts of a particular military equipment. Defence Minister Parrikar has stated that the SP model is likely to be finalised "soon".


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India as "major defence partner" for the USA

In one of his last major actions concerning India, US President Barack Obama codified legislation that approved a $619 billion budget for the US military in 2017 and also defined India as a 'Major Defence Partner,' which is distinctly unique. The legislation has been called "symbolic, expressing a sense of where Congress stands on ties with India," as an expert has said, matching that which the USA has with Israel.

While welcoming this, the Government of India has stated that it "locks in" all future administrations to the definition. Benjamin Schwartz, who then headed the India desk at the Pentagon has stated that the intent was to bolster India as "pre-dominant security provider in the Indian Ocean Region" (to offset China's military superiority). The first report under this law will come in around June 2017 from the incoming administration of President Donald Trump, who has said, at an election rally in November that India and the US will be "best friends on his watch".

Air Chief Marshal Birender Singh Dhanoa takes over as 25th Air Chief

Air Chief Marshal Birender Singh Dhanoa took over as the 25th Chief of the Air Staff on 31 December 2016. In his address to the IAF, Air Chief Marshal Dhanoa said that he was "honoured and privileged to have been entrusted with the responsibility to lead one of the finest Air Forces in the world" and would "certainly be inspired by the exceptional achievements and the leadership of so many of my illustrious predecessors."

He spoke on the IAF's modernisation and transformation into a strategic aerospace power with full-spectrum capability, highlighting new acquisitions and replacement of obsolete equipment as steps that would bolster the force's capabilities. He said that it had "been a matter of great national pride" to commission the first Tejas LCA squadron and noted that while undertaking its modernisation, the IAF "has taken an active and sustained role in the 'Make in India' plan to take forward indigenous production of combat aircraft, helicopters, weapon sensors and systems."

In his address, he also expressed satisfaction at the way India's image worldwide has been showcased through the IAF's strategic reach, and commended the Air Force's role as first responders in HADR situations. He stressed the requirement of training and equipping IAF to deter sub-conventional threats, and reiterated the need to enhance aerospace safety. He renewed the IAF's commitment for a better standard of living for its air warriors, whom he urged to follow the fine traditions of the Air Force.

Commissioned into the Flying Branch of the IAF as a fighter pilot in June 1978, Air Chief Marshal BS Dhanoa is a Qualified Cat 'A' Flying Instructor and has more than 3,000 hours of fighter flying with an immaculate flight safety record. An alumnus of the Rashtriya Indian Military College, Dehra Dun, the National Defence Academy and the Defence Services Staff College, Wellington, he commanded No.17 Squadron 'Golden Arrows' flying MiG-21Ms during Operation *Safed Sagar* the Kargil Conflict of 1999. For his bravery and leadership, he was awarded the Yudh Seva Medal (YSM).

The Air Chief Marshal has held a number of staff appointments at operational Commands, Joint Training Establishments and Air Headquarters. He has been Director Targeting Cell and Director Fighter Operations, Assistant Chief of Air Staff (Intelligence) at Air HQ and Senior Air Staff Officer of Eastern and Western Air Commands. The Air Chief was earlier AOC-in-C South Western Air Command. For his experience and professional excellence, he had been handpicked to establish an 'IAF Training Team' in a strategically important neighbouring country.

Air Chief Marshal Dhanoa was also instrumental in developing an aerial targeting philosophy against potential adversaries and transformed the concept of air operations of the Indian Air Force to align with contemporary air war fighting practices. Before taking over as the Chief of the Air Staff, he was the Vice Chief of the Air Staff since 1 June 2015.

New CAS flies solo in MiG-21M

Shortly after he took over as the new CAS, Air Chief Marshal Birender Singh Dhanoa, flew a solo sortie in a MiG-21M (Type 96) at Utarlai Air Force Station in the western state of Rajasthan. The MiG-21M is the oldest fighter type in the IAF inventory, and is currently only operated by two frontline units, No. 35 Squadron 'Rapiers' and No. 108 Squadron 'Hawkeyes.' This was Dhanoa's first visit to a forward operational base as Chief, so as "to assess operational readiness and review the morale of the personnel stationed there".

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The Air Chief Marshal has personal association with the MiG-21M, having flown this type in combat, as CO No. 17 Squadron 'Golden Arrows' during Operation *Safed Sagar* ('White Sea') the name assigned to the Indian Air Force's operations in the 1999 Kargil Conflict. Although nominally based at Bathinda, the unit operated from Srinagar in the north during the conflict. The *Golden Arrows* conducted extensive fighter-recce missions through the Operation, in addition to strike missions by day as well as night. By the end of the conflict, No. 17 Squadron were the most decorated unit of Operation *Safed Sagar*, earning one VrC (Sqn Ldr Ajay Ahuja, posthumously), a Yudh Seva Medal (to Wg Cdr Dhanoa for distinguished service during wartime), two Vayu Sena Medals (for gallantry, to Sqn Ldr A Choudhry and Flt Lt RS Dhaliwal), as well as two Mentions-in-Despatches (Sqn Ldr Anil Kumar and Flt Lt VN Rao).

No. 17 Squadron was 'numberplated' in 2011, but will reportedly be re-established in 2019 as the IAF's first unit to equip with Dassault Rafale multirole fighters (*see separate item*).

General Bipin Rawat appointed as COAS

In a ceremony at South Block on 31 December 2016, General Dalbir Singh handed over his baton to General Bipin Rawat, who took over as the 27th Chief of the Army Staff. General Rawat was earlier Vice Chief Army Staff (VCOAS).

General Bipin Rawat was commissioned in the 5th Battalion of the 11th Gorkha Rifles in December 1978, and was awarded the 'Sword of Honour' at the Academy. Having vast experience in high altitude warfare and counter insurgency operations, he has commanded an Infantry battalion along the Line of Actual Control in the Eastern Sector, a Rashtriya Rifles Sector and an Infantry Division in the Kashmir Valley, a Corps in the Eastern theatre before becoming GOC-in-C Southern Command. The General Officer had earlier attended the Command and General Staff College (CGSC) course at Fort Leavenworth, Kansas, USA.

Gen Rawat has also held a range of staff appointments at the Directorate General of Military Operations and Military Secretary's Branch at Army HQ. He has also been Major General, General Staff (MGGS) at HQ Eastern Command, before which, he had commanded a Multinational Brigade, in the Democratic Republic of Congo (MONUC) where he was twice awarded the Force Commander's Commendation.

Preparations for IAF Rafale induction

Dassault Rafale of the Armée de l'air

It is reported that a high level Indian Air Force and MoD team has recently visited France for continued discussions on the Dassault Rafale programme, formalising modalities for payment of the second tranche as also working out logistics in preparation for the establishment of facilities at two air bases selected for this new generation fighter.

According to reports, the two squadrons with Rafales (first of which will be No.17 'Golden Arrows,' presently number plated and formerly flying MiG-21Ms) will be based at Sarsawa, near Saharanpur in Western Uttar Pradesh and at Hasimara in the Dooars of West Bengal. According to contract, first deliveries of Rafales to the IAF would commence after 36 months but these are likely to be brought forward by some months.

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Additional Sukhoi Su-30MKIs for IAF ?

Sukhoi Su-30MKIs were dominant once again during the Republic Day fly past in 2017, as they are in the Indian Air Force's order of battle. Even as HAL's Nasik Division continues to produce some 12 Su-30MKIs per year, with some 190 numbers delivered so far, the last of those on current order are scheduled to be delivered by 2020. There are indications that an additional batch of 42 Su-30MKIs will follow. Meanwhile, clearance of the long planned Su-30MKI upgrade programme is imminent, with Chairman HAL Survarna Raju stating that an official announcement would be made in this regard shortly. The upgraded Su-30MKIs would incorporate new displays, avionics and an AESA radar, with HAL assuming leadership in the programme.

Tejas LCA production ramped up

Series production of the Tejas light combat aircraft (LCA) is being ramped up at HAL's Bangalore Complex, with two separate facilities undertaking this task. While the new hangars built for the purpose near the NFTC building will be tasked for production of upto eight LCAs annually, the hangars at Aircraft Division earlier producing Kirans and lately Hawks, are gearing up for manufacture of, again, upto eight LCAs a year. The first three series production LCAs delivered to the IAF for its first squadron (No.45) have been delivered while SP-4 and SP-5 are currently being completed, the first mentioned slated to fly "shortly" while the latter is now being equipped at the erstwhile Kiran final assembly hangar.

Orders for the first batch of 20 LCA Mk.Is are to be followed by a second tranche of 20 aircraft even as HAL's ARDC are working on development of the Mk.IA, 83 of which have been approved for acquisition by the DAC.

Expansion of Army Aviation Corps

According to authoritative sources, the Indian Army's Aviation Corps are likely to acquire three new types of helicopters, some in replacement of the ageing Cheetahs and Chetaks in inventory as also augmenting of attack squadrons with new generation Apache attack helicopters. These would be in addition to the 22 Boeing AH-64 Apache multirole combat helicopters earlier ordered for the Indian Air Force.

The Kamov Ka-226T, to be coproduced by HAL would be in addition to the indigenous Light Utility Helicopter (LUH) and Light Combat Helicopter (LCH) which are under development by HAL, with the Indian Army as prime operator (*see additional item in this Issue*).

IAF Hawk AJTs reach 100,000 flight hours

The Indian Air Force fleet of Hawk Mk.132 advanced jet trainers has accumulated a total of 100,000 flying hours as of end-2016. Congratulating the Indian Air Force, Steve Timms, Managing Director - Defence Information, Training and Services, BAE Systems said, "The Indian Air Force's Hawk advanced jet trainer is a compelling story of success, providing new generation training to next generation air warriors and delivering our commitment to 'Make in India' in partnership with Hindustan Aeronautics Limited (HAL). The Indian Air Force is one of the largest operators of the Hawk globally and we wish its air warriors safe landings."

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The Indian Navy also operates the Hawk Mk.132, with 17 examples in service. Meanwhile, BAE Systems is pursuing a third order for 20 Hawks to equip the IAF's *Surya Kiran* Aerobatic Team. BAE Systems and HAL have already delivered 123 Hawks to the Indian Air Force and Navy, under a 66-aircraft order signed in 2004, plus a second 57-aircraft order in 2010.

Additional C-17 for IAF

The Indian Air Force's present inventory of ten Boeing C-17 Globemaster III strategic airlifters will be augmented by an additional aircraft. Although the IAF had requested acquisition of three more C-17s, there was only one left with the manufacturers at Long Beach, California, where the C-17 production had closed down in November 2015. Procurement of this final C-17 was cleared by the Defence Acquisition Council at its meeting in New Delhi on 23 December 2016. The IAF's Boeing C-17s are operated by No. 81 Squadron 'Skylords' based at Hindon, north of Delhi.

IAF-RAFO Ex *Eastern Bridge IV*

The Air Forces of India and the Sultanate of Oman conducted their bilateral air exercise *Eastern Bridge IV*, at Jamnagar AFS in Gujarat from 16 January 2017. The Royal Air Force of Oman participated with five F-16 Block 50 fighters from No. 18 Squadron based at Thumrait, while the IAF flew locally-based MiG-29s and maritime strike Jaguars, as well as Su-30MKIs and MiG-27s from other air bases.

On 18 January, the Chiefs of the two Air Forces, Air Chief Marshal BS Dhanoa and Air Vice Marshal Matar bin Ali Al-Obaidani, *(in photo)* arrived at Jamnagar to review the exercise, interact with participating aircrews, and hold bilateral discussions. *Ex Eastern Bridge IV* was the first time that RAFO F-16s participated in an air exercise outside the Gulf countries.

"Indian Army ready for two front war", says new COAS

India's newly appointed Army Chief, Gen Bipin Rawat, has said in an interview that the Indian Army is prepared for a two-front war involving Pakistan and China simultaneously but emphasised on "the need to look at cooperation and not confrontation with Beijing." The Army Chief said, "As far as armed forces are concerned, we are tasked to be prepared for a two-front war and I think we are capable of carrying out our task in whatever manner that we may be asked to do by the political hierarchy. Our country, our army wants peace and tranquillity at the border. But it does not mean that we are weak. We are capable and powerful in all forms and if need be, we will not shy away from using our power in any form. Our aim is that peace is maintained at the border. But I will say it again that if need be, we will not hesitate in using our power."

Expert Panel Recommendations on 'CDS'

The Ministry of Defence-appointed expert panel on 'Defence Reforms', headed by Lt Gen DB Shekatkar (retd), has recommended appointment of a new four star rank officer – who may be designated Chief of Defence Staff (CDS) or Permanent Chairman, Chiefs of Staff Committee (PC-COSC) – as a single point military adviser to the government. The 11-member committee was formed on Defence Minister Manohar Parrikar's orders in May 2016 to study measures for 'Enhancing Combat Capability and Rebalancing of Defence Expenditure' had submitted its report to the Defence Minister on 21 December 2016. India's defence reforms are long overdue with various committees having

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also made similar recommendations earlier. After the 1999 Kargil War the Group of Ministers (GoM) under LK Advani and the Naresh Chandra Committee, set up by the UPA-II government recommended appointment of a CDS but no action has been taken so far.

Further, any moves to reduce the Army's present manpower strength of 1.18 million has been rejected in view of the Army's defences against both China and Pakistan. Still, to rationalise manpower the panel has recommended that the role of non-combat organisations paid from the defence budget, such as the Defence Estates, Defence Accounts, DGQA, DRDO, Ordnance Factory Board (OFB) and NCC (National Cadet Corps), be subjected to a performance audit. Once a professional review is carried out substantial savings can be made by rationalising and downsizing manpower at these organisations.

Akash missiles offered to Vietnam ?

India is actively pursuing the possible sale of indigenously-developed Akash Surface-to-Air Missiles (SAMs) to Vietnam. India has close ties with Vietnam and wants to boost its relationship to counter China's growing belligerence against India and in the South China Sea. India's relationship with Vietnam seems to be a major thrust area for Indian strategic planners.

The Akash, a 25 km range SAM developed by DRDO, is in service with the IAF and Army. In addition India has been training Vietnamese navy personnel on Russian-origin *Kilo*-class submarines for the last three years. This year the Indian Air Force will also start operational flying training of Vietnamese fighter pilots in Sukhoi Su-30MKI fighter aircraft.

Test-firing of Agni-IV

The New Year was heralded with successful test firing of India's nuclear capable strategic missile, Agni-IV on 2 January 2017. The test was carried out by the Strategic Forces Command from a road-mobile launcher on Abdul Kalam Island, off the Odisha coast. The Agni-IV surface-to-surface ballistic missile has a 4,000 km range and a nuclear warhead weighing up to one tonne. Developed by the Defence Research and Development Organisation (DRDO), the Agni-IV is a solid fuel, two-stage missile that is 20 metres long and weighs 17 tonnes. Agni-IV has been launched five times in the past: in 2011, 2012, twice in 2014 and once in 2015. All five tests were successful.

Agni-V tested...

Earlier, India's longest-range nuclear capable ballistic missile, Agni-V, was successfully test fired on 26 December 2016 from Abdul Kalam Island (formerly Wheeler Island) off the Odisha coast. This was the fourth test carried out by the Defence Research and Development Organisation (DRDO), and the missile is reportedly now cleared for operational deployment. With a range of more than 5,000 km Agni-5 falls in the category of Inter-Continental Ballistic Missiles (ICBMs) and can impact targets for instance deep inside China. The solid propellant missile has a warhead of 1,000 kg and

is canisterised, which gives it all-weather, all-terrain mobile launch capability. Agni-V is the latest in India's 'Agni' family of short, medium and intercontinental range missiles, with new technology for navigation and guidance. The 17-metre long Agni-V weighs about 50 tonnes and will be employed alongside existing Agni-I, II, III and IV missile systems and BrahMos cruise missiles.

...and Chinese reactions

Predictably, the Chinese have reacted with an editorial in *The Global Times* stating that, "In general, it is not difficult for India to produce intercontinental ballistic missiles which can cover the whole world. If the UN Security Council has no objection over this, let it be. The range of Pakistan's nuclear missiles will also see an increase." China's use of Pakistan to contain India is not new, and it has not only supplied conventional arms to Pakistan but has been responsible for proliferation of nuclear weapons by supplying nuclear and missile technology to Pakistan.


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Increase in helicopter production planned by HAL

The Indian Armed Forces have stated requirements for well over 700 helicopters of various categories including light utility, armed and medium multi-role types. According to sources in New Delhi, the Ministry of Defence (MoD) have asked the public sector undertaking Hindustan Aeronautics Limited (HAL) to ramp up production, speed up existing under-development projects and start out-sourcing work. HAL's Helicopter Complex at Bangalore currently produces 22-24 Dhruv ALHs *(photo above)* per annum but production of light utility helicopters (LUH) *(photo below)* is assuming priority considering that the Army and Air Force urgently need to supplant their inventory of ageing HAL-built Cheetahs and Chetaks. HAL would have to produce up to 85-90 helicopters a year three types – the ALH, LUH and LCH — with out-sourcing of some work being suggested on the lines of global manufacturing practices.

India's three armed services need some 485 light utility helicopters, the Army requiring 259, IAF 125 and Navy around 100 such helicopters, the latter also for embarking on warships. In addition, the Army and the Air Force have requirements for some 180 light attack helicopters. In addition, the Coast Guard and other paramilitary forces have requirements for 100 helicopters. Meanwhile, HAL has planned to establish a new helicopter production facility at Tumkur, 100 km from Bengaluru, which will start production in 2018.

16 microlights for NCC

It is reported that 16 new microlight aircraft (Pipistrel Virus FW80 'Garud') have been cleared for supply to the National Cadet Corps (NCC) Air Wing, which is the start of a plan to acquire some 100 Virus FW80s for air wing squadrons throughout the country. The initial induction would be to NCC Squadrons in Punjab, Haryana, Himachal Pradesh and Chandigarh, six microlights having been inducted in NCC squadrons at Amritsar, Jalandhar and Ludhiana. In the second phase this year, an additional six will be procured for squadrons based at Chandigarh, Patiala and Karnal. The third and final phase will see squadrons at Hissar and Kulu getting new aircraft in 2019.

Second Project 75 submarine *Khanderi* launched

INS *Khanderi*, second of the Indian Navy's *Scorpene*-class (Project 75) diesel-electric submarines, was launched at Mazagon Dock (MDL) on 12 January by the Minister of State for Defence, Dr Subhash Bhamre in the presence of Admiral Sunil Lanba, CNS.

This submarine will now enter sea trials and is expected to be delivered to the Navy by year-end. She is named after a decommissioned Indian Navy *Foxtrot*-class submarine that was in turn named for *Khanderi* Island off the coast of Mumbai. The first boat of the class, *Kalvari*, is presently undergoing sea trials and is likely to be commissioned into the Navy by mid-2017.

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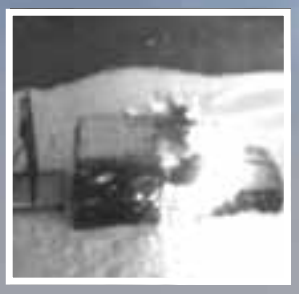

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Coast Guard Exercise (NATPOLREX-VI)

The Indian Coast Guard (ICG), being central coordinating authority for oil spill response, has put into place a robust pollution response system to check the preparedness levels of oil handling agencies at regular intervals. To address oil-related mishaps, the Coast Guard conducted the sixth edition of the *National Level Pollution Response Exercise* (NATPOLREX-VI) on 20-21 December 2016 off Mundra in the Gulf of Kutch. A number of ICG ships, two ICG helicopters, two ICG Dornier 228s, one Indian Navy vessel, one IAF C-130J Super Hercules, three tugs from KPT/Mundra Port, one tanker from the Shipping Corporation of India, two MSVs/ OSVs from other resource agencies and beach cleaning teams from State Governments also participated in the exercise.

CCS clears 12 more HAL-built Dornier 228s for Navy

On 23 November, the Indian Cabinet Committee on Security approved procurement from HAL of 12 upgraded Dornier Do 228 surveillance/patrol aircraft for the Indian Navy, at a cost of Rs 2,500 crore ($364 million). The Do 228s will be built at the Company's Transport Aircraft Division in Kanpur and will incorporate forward-looking infrared cameras, electronic support measures, satellite communication, and data secrecy equipment as well as traffic collision avoidance and enhanced ground proximity warning systems. This acquisition had been sanctioned by the Defence Acquisition Council (DAC) in October 2014 (*see Vayu VI/2014*).

GE LM2500s to power Indian Navy's P17A frigates

GE Marine Solutions' LM2500 marine gas turbines will power the Indian Navy's Project 17A stealth frigate, currently under construction at Mazagon Dock Limited (MDL) and Garden Reach Shipbuilders and Engineers (GRSE). These LM2500s are to be delivered by Hindustan Aeronautics Limited's Industrial and Marine Gas Turbine division in Bangalore, India, under licence from GE. The LM2500 already powers the Navy's *Shivalik*-class (P17) frigates as well as the *Vikrant*-class aircraft carrier (IAC-1) currently under construction at Cochin Shipyard Limited. HAL has delivered 11 LM2500 gas turbines to the Indian Navy, and is also licenced to provide service and support, including inspection, spare parts, maintenance and equipment overhauls, for GE industrial and marine gas turbines.

CSL completes construction of 20 FPVs

Cochin Shipyard Limited has completed construction of a series of 20 *Aadesh*-class Coast Guard Fast Patrol Vessels (FPVs) for the Indian Coast Guard. CSL delivered the first vessel on 25 September 2013, subsequently vessels were delivered at two months intervals and CSL began delivering the boats ahead of schedule from the 13th FPV onward. On 30 December 2016, ICGS *Ayush*, the 20th and final FPV in the series was delivered, concluding the overall contract three months ahead of schedule. ICGS *Ayush* will be operated from the Coast Guard Station at Krishnapatanam.

Domestic air traffic rises by 24%

Increasing number of passengers flew with the various airlines of India during December 2016 which recorded 23.91% more than in the previous year, according to data from the DGCA. According to this, all the national scheduled carriers had an average load factor of over 80%, led by SpiceJet that recorded a load factor of 93.7%, the 21st continuous month that this airline had over 90% occupancy. IndiGo flew 40.3% of total passengers in December, followed by GoAir with 90.7% load factor. SpiceJet also topped the chart of airlines that flew the highest number of flights on time.

The data shows that SpiceJet flew 70% of its flights on time at four airports: Delhi, Mumbai, Hyderabad and Bangalore. Jet Airways and Jet Lite, which together accounted for 17.9% of total passengers flown in the country, has emerged as the second largest carrier, and came second in on-time performance (OTP) by flying 64.3% of its flights on time, followed by Vistara that flew 64.2% of its flights on time. Air India was last in the line with some 59% of its flights on time.

Bids from 11 companies for 190 air-routes under 'UDAN'

The Ministry of Civil Aviation have reportedly received bids from 11 companies for some 190 routes under the regional air connectivity scheme (*see article Udan Khatola in this Issue*). Of these there are 49 proposals to link 43 un-served airports as also 12 underserved ones, the last date for applications being 16 January 2017. Amongst these are Bikaner, Jaisalmer, Jalgaon, Pant Nagar and Cooch Behar.

According to sources there will now be rounds of counter bidding while the technical bids are to be opened on 3 February, the route being awarded to the bidder seeking the lowest viability gap funding.

GoAir firms order for 72 additional A320neo

GoAir, a Wadia Group company, has signed a firm contract for 72 A320neo aircraft following a Memorandum of Understanding (MoU) inked during the Farnborough International Airshow (*see Vayu IV/2016*). The agreement, reached on 30 December 2016, doubles GoAir's firm order book for the aircraft type to 144, and is valued at an estimated Rs 52,000 crore.

"This new order will further strengthen our network by adding more domestic and international routes in the years to come," said GoAir Managing Director and CEO Wolfgang Prock-Schauer. The airline has already received government approval to fly to nine countries including Iran, Uzbekistan and Kazakhastan, and is likely to start international operations this year. GoAir took delivery of its first A320neo in June 2016 and now operates a fleet of 23 A320-family aircraft. GoAir was the first airline to procure the A320neo in the Spaceflex configuration with galleys and lavatories located at the rear of the cabin, increasing seat count to 186. IndiGo are also flying a significant number of A320neos while Air India is expected to take delivery of its first A320neo in mid-February 2017.

SpiceJet in mega deal for 205 Boeing 737 MAXs

On 13 January 2017, SpiceJet and Boeing announced a deal for the purchase of up to 205 narrowbody airliners, enhancing the airline's existing 55-aircraft order with a 100 firm B737-8 MAX orders and purchase rights for an additional 50 B737-8 MAX and wide-body aircraft. The total order of 205 aircraft is valued at $22 billion and is the biggest in recent Indian aviation history, marking a clear turnaround for SpiceJet which provides it "the ability to capitalise on the robust demand forecast in the

world's fastest growing aviation market." SpiceJet currently operates 32 Next-Generation B737s and 17 Bombardier Q400s. The 737 MAX incorporates the latest CFM International LEAP-1B engines, Advanced Technology winglets and other improvements to deliver class-leading efficiency, reliability and passenger comfort in the single-aisle market.

IndiGo's 125th Airbus A320

As IndiGo took delivery of its 13th Airbus A320neo aircraft on 27 December 2016, Aditya Ghosh, President of IndiGo said, "The delivery of the 125th aircraft in the 125th month of our operation is indeed a landmark occasion for us …reinforces our commitment towards the industry and living our promise of providing the best flying experience to our passengers. The entire IndiGo team has worked extremely hard to reach where we are today and we are raring to go".

Air India to induct 100 more airliners

It is reported that the Government has cleared Air India to induct 100 new airliners but under lease arrangements for which no additional budgetary proposals would be made. According to the Civil Aviation Secretary RN Choubey, this is part of the turnaround plan, with Air India is planning a fleet of 232 aircraft, including those on lease, by March 2020. Meanwhile, the first of 29 Airbus A320neos being leased by Air India are scheduled to arrive in mid-February 2017 while additional numbers are also planned for leasing. As part of expansion, Air India Express is to lease 18 more Boeing 737s, adding to its present fleet of 17 737s.

Lufthansa Technik landing gear support for Air India

Air India and Lufthansa Technik have an agreement for maintenance and repair of the carrier's Boeing 777-200/300 landing gears, the contract covering a total of 15 shipsets. The maintenance and overhaul work will be performed by Lufthansa Technik Landing Gear Services UK (LTLGS) located in Hayes, London. The first Boeing 777-200/300 landing gear delivery to Air India also marks an important milestone for LTLGS: the 50th Boeing 777-200/300 landing gear overhauled by LTLGS since 2013, which amounts to a market share of approximately 70% in the currently anticipated global market.

Vistara completes two years of operations

On 9 January Vistara, the Tata Sons and Singapore Airlines JV airline, marked two years of services in Indian skies. Vistara currently operate more than 500 flights per week across a growing network of 20 destinations across India, served by a fleet of 13 Airbus A320s. The airline has flown over 3.5 million customers, consistently recorded a high On-Time Performance (OTP) and secured awards and recognition from industry bodies and airline publications.

Rolls-Royce and RGNAU MoU on aviation studies

Rolls-Royce has signed a Memorandum of Understanding (MoU) with Rajiv Gandhi National Aviation University (RGNAU) to build future competencies for the Indian aviation industry. The signing ceremony took place in the presence of President Pranab Mukherjee, Air Vice Marshal Nalin Kumar Tandon (retd), Vice Chancellor of RGNAU, and Kishore Jayaraman, President-India & South Asia, Rolls-Royce.

RGNAU was set up to facilitate and promote aviation studies and research, and will function from Fursatganj in Uttar Pradesh. The MoU the manner in which Rolls-Royce will support RGNAU develop curricula and offer international experts for guest lectures to help the maturity of the university.

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First HAL-built civilian Do 228

Minister of State for Civil Aviation, Jayant Sinha, inaugurated structural assembly of the first HAL-built Dornier 228 intended for the civilian market at HAL's Kanpur facility on 11 December 2016. HAL CMD T Suvarna Raju expects the first aircraft to roll out by April 2017. The Do 228-201 is a 19-seat commuter aircraft currently manufactured at HAL's Transport Aircraft Division (TAD) in Kanpur, and is promoted by HAL to be a "most suitable product under 'Make in India' to support the Regional Connectivity Scheme (RCS) of the Ministry of Civil Aviation." As a proactive step in this direction, HAL's board had sanctioned Rs 100 crore for two civil variants of the Do 228, even though there are no airline orders for these aircraft yet. "We see a big business opportunity in this segment for next 10 years," said Suvarna Raju.

Air India's Rs 750 crore bills outstanding

Air India has generally been at the receiving end of criticism for its poor performance and huge losses but it was recently revealed that the Government of India owes the airline a massive Rs 750 crore. The flag carrier is utilised for flying VVIPs such as the President, Prime Minister and politicians with 'Z' category security cover. Still, Air India made a small operating profit of Rs 105 crore in the previous financial year (2015-2016) but remains loss-making overall owing to a large debt burden, among other factors. The airline had received a bailout package of Rs 30,000 crore from the previous UPA government, but needs additional funds to sustain its turnaround plan.

Navi Mumbai airport delay

The Navi Mumbai international airport is unlikely to meet its 2019 inaugural deadline with three of the qualified bidders raising questions about the timeline and cost overruns involved in executing the Rs 16,000-crore project. The four bidders who had qualified for the project are Tata Realty & Infrastructure, Hiranandani Group, GMR Infrastructure and GVK Power & Infrastructure. The first three have expressed serious concerns on completing the project by 2019. GVK Infrastructure is the only firm that has not expressed reservations to meet the 42-month deadline which the state government plans to set.

A Tata Realty official said the deadline set by City and Industrial Development Corporation (Cidco), a planning agency of the state government, was "ridiculous." While Cidco anticipates completion within three-and-a-half years, but "ground-levelling work itself will likely take over two years." However, Cidco still claims that one runway will be operational by 2019 and the entire airport ready by 2020.

Strategic disinvestment in Pawan Hans

Moving ahead with the strategic sale of Pawan Hans (erstwhile Helicopter Corporation of India), on 13 January 2017 the Government announced its intention to sell off its entire 51 per cent stake and to transfer management control. Pawan Hans is a joint venture where state-owned ONGC presently holds 49 per cent. As per the public notice, issued by the Department of Investment and Public Asset Management, a transaction advisor is to be identified from "reputed professional consulting firm, investment bankers, merchant bankers, financial institutions and banks" who would provide advisory services and manage the strategic disinvestment process. The deadline for sending the applications is 2 February 2017.

Indian MRO market to grow by 2036

In December 2016, KPMG in India unveiled a background paper on the MRO sector that underlined the growth of the civil aviation, and projected that Indian carriers will grow to operate some 1,740 aircraft in total over the next 20 years, while the MRO market would swell commensurately to $5.2 billion by 2036. The paper was formally released by Ashwani Lohani, Chairman and Managing Director, Air India, in the presence of Stephane Lauret, CEO, Safran India, Dr BP Sharma, CMD, Pawan Hans, HR Jagannath, CEO, Air India Engineering Services, Ravi Menon, Executive Director, Air Works India, and Pulak Sen, Founder Secretary General of the MRO Association of India. The paper highlighted the opportunities in the Indian MRO industry, the impact of the new National Civil Aviation Policy (NCAP 2016), the proposed Goods and Services Tax (GST), the Regional Connectivity Scheme (RCS), and addressing challenges related to service quality, leasing, financing, certification and skill development.

Induction of OFB Dhanush 155 mm howitzer

India's indigenously produced 'Dhanush' 155 mm/45 calibre field gun is in the last stages of trials before induction into the Indian Army, which has conducted final high altitude trials in the areas of responsibility of the Srinagar-based 15 Corps and Leh-based 14 Corps. The Army is carrying out trials with six guns in snow-covered mountains with temperatures as low as -10°C. A production level prototype has been tested and this is the final test before the Ordnance Factory Board (OFB) is cleared to start mass production. Hot weather trials for the gun were earlier held in Rajasthan's Thar Desert at Pokhran.

Dhanush has a range of 38 km and is based on the Bofors 155 mm/39 calibre guns that were procured by the Army in the 1980s under a transfer of technology agreement with the Swedish company. Compared to the original Bofors gun, Dhanush is an improved version with greater range, accuracy, reliability, angle of fire and 'shoot-and-scoot' capabilities. The guns will be manufactured at OFB's Gun Carriage Factory in Jabalpur. The Army has already indented for the first 114 guns worth Rs 1,260 crore, the last of which will be delivered after approximately 3 years, the Army's requirement being for over 400 howitzers of this type.

145 M777 howitzers for Indian Army

BAE Systems has received a $542 million contract from the US Department of Defence to provide 145 M777 ultra-lightweight howitzers to the Indian Army through a *Foreign Military Sale*. "The 155mm ultra lightweight howitzer will give the Indian Army superior artillery capability," said Joe Senftle, vice president and general manager of Weapon Systems at BAE Systems.

The Indian military joins those of the US, Canada and Australia in operating the M777, "which delivers rapid reaction capability in sustained combat conditions, owing to its digital fire control system

and ability to be airlifted by helicopters." Work on the contract will begin immediately and be performed by BAE Systems and its suppliers across the United Kingdom, United States and India, with deliveries scheduled to begin in June 2017. The first batch of 20 guns will be delivered directly from the USA, while the remainder will be produced in India in collaboration with M&M.

Army to 'retire' Cheetah and Chetak helicopters

The Indian Army will shortly begin retiring its ageing fleet of Chetak (SA 316B Alouette III) and Cheetah (SA 315B Lama) helicopters after a string of recent accidents. These light utility helicopters are based on an almost 50 year-old design built by Hindustan Aeronautics Limited (HAL) under licence from Aerospatiale of France. Initially the Army will replace about 40 Cheetah/Chetaks with the indigenously designed and built Dhruv Advanced Light Helicopters (ALHs), the remaining force to be replaced and augmented by Russian-origin Kamov Ka-226Ts, sixty of which will initially be procured directly from Russia in flyaway condition and the remaining 140 licence-built by HAL under a joint venture between HAL, Russian Helicopters and Rosboronexport.

Pinaka Mk.II with guided rockets

On 12 January 2017, the first test firing of the Pinaka guided rocket took place from Chandipur, in Odisha. The unguided version (Pinaka Mk.I) can engage targets 38 km away, and the guided version (Pinaka Mark II) will virtually double that range, to about 65 km. The Army is particularly keen to acquire the follow on Pinaka Mk.II, where each individual guided rocket is guided separately using INS and GPS, with an on-board computer calculating its flight path, and a transmitter and receiver on the launcher sending signals to keep it on path. To correct its flight path, the rocket is manoeuvred via thrust vectoring.

The Pinaka Multi-Barrelled Rocket Launcher (MBRL) consists of 12 tubes mounted on a high-mobility Tatra vehicle, each of which fires a rocket, which can be fired in a salvo, less than four seconds apart. A battery, with six Pinaka launchers, fires 72 rockets in 44 seconds. The salvo effect is "devastating", bringing down immense firepower on the target before enemy troops can take cover. The MoD has cleared acquisition of another two regiments (18 launchers each) of the Pinaka Mark I for Rs 3,230 crore, supplementing two regiments bought earlier.

Additional Mechanised Infantry Battalions

It is reported that the number of mechanised infantry battalions of the Indian Army will be increased by four, with the Brigade of Guards raising three new units and the Mechanised Infantry Regiment in the process of adding one more to its existing strength of 26 battalions. The new raisings come even as the CAG had commented a year back that the Army faced an acute shortage of Mechanised Infantry Combat Vehicles (MICVs). This, CAG had remarked, would have an adverse impact in the 12th Army Plan as several new mechanised infantry battalions were planned to be raised.

The Indian Army's mechanised Infantry units are equipped with Russian-origin but Indian-manufactured BMP-2 (*Boyevaya Mashina Pekhoty*) infantry combat vehicles. The Indian Army's Mechanised Infantry units were earlier moved from the jurisdiction of the Directorate General Infantry at Army Headquarters to the Directorate General Mechanised Forces that oversees functioning of the Armoured Corps and Mechanised Infantry (*photo of BMP-2s at Army Day Parade on 15 January 2017 by Angad Singh*).

Tata Motors confident of producing FICVs

Tata Motors is confident that it will be in a position to manufacture and supply future infantry combat vehicles (FICV) to the Indian Army. Tata Motors are one of the five entities competing for the order to supply about 2,600 units of the FICV, with Mahindra & Mahindra, Reliance Defence, L&T, Ordnance Factory Board (OFB) being the other companies in the fray.

While the state-owned OFB has "automatically" made it to the short list, the government will select two companies and award the contract to one of them. Tata Motors has joined hands with Pune-based Bharat Forge and General Dynamics Land Systems for the project, which would be divided 60:40 between the two top contenders, after modification and trade-offs as required by the Army.

AXISCADES and QuEST contract from Airbus

Airbus has signed a strategic agreement with QuEST Global and AXISCADES to provide a range of critical engineering services for all Airbus aircraft programmes as tier-1 suppliers. QuEST will provide services for wings and AXISCADES for fuselages. This is the second order that AXISCADES and QuEST have received for these engineering services through a competitive bidding process after the previous contract successfully completed its term. Both companies

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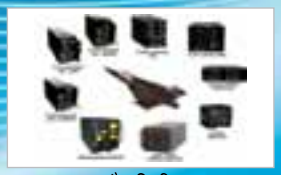
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operate dedicated development centres in Bengaluru and over 500 engineers will be working across these centres to deliver the services.

In the picture above are (L-R): Ajay A Prabhu, COO, QuEST Global, Robert Nardini, HO Airframe Engineering, Airbus, Srinivasan Dwarakanath, President, Airbus Division in India, Bernard Richardot, HO Product Development Procurement, Airbus, and Sudhakar Gande, Vice Chairman, AXISCADES.

'Technology Leadership' Award for HAL CMD Suvarna Raju

On 1 December 2016, the Institute of Engineers (India) awarded a 'Technology Leadership Award' to T Suvarna Raju, Chairman and MD of Hindustan Aeronautics Limited (HAL). About 600 delegates from industries, R&D laboratories and academia participated in the congress, with the theme 'Excellence in Engineering Practice: Networking and Collaboration.'

Addressing the gathering Mr. Suvarna Raju said that, "HAL has been adapting 'engineering innovation' to remain competitive in the manufacturing sector. The new engineering technology that will enhance the manufacturing competitiveness is '3D printing' and towards this HAL has procured rapid prototyping machines to explore manufacturing of components."

'Corporate Governance Award' for HAL

ASSOCHAM has bestowed the 'Corporate Governance Excellence Award 2015-16' to HAL, in the category for unlisted public sector companies with revenue of over Rs 500 crore. The Union Minister of State for Finance and Corporate Affairs Mr. Arjun Ram Meghwal, presented the award to HAL CMD T Suvarna Raju in New Delhi on 2 December 2016. "This is a great honour and I share this award with our board, management leadership and employees who have set high standards of governance. We will continue to maintain and enhance the highest standards of Corporate Governance that we have set for the organisation," said Suvarna Raju as he accepted the award.

Indian start-up companies benefit from defence orders

Start-up companies in India are receiving "encouraging orders from the defence forces". Some of these companies are involved in manufacturing hi-tech systems such as drones and imaging systems. The Indian Army increasingly relies on small Unmanned Aerial Vehicles (UAVs) for border surveillance along the India-Pakistan border. IdeaForge, a small Mumbai-based company that was started in 2008 by three IIT-Bombay graduates makes these hand held UAVs, whose flagship product Netra, was jointly developed with the DRDO. Meanwhile, Bengaluru-based Tonbo Imaging makes digital imaging systems for military equipment such as guns, UAVs and battle tanks, and derives the bulk of its revenue from domestic and export military orders.

Airbus to set up aerospace cluster in Gujarat

Some 24,000 MoUs were signed during the 'Vibrant Gujarat Global Summit' in January 2017, including an agreement with Airbus, which plans to establish an aerospace and defence cluster at Dholera, which Special Investment Region is some 100 kilometres from Ahmedabad International Airport. Deputy Chief Minister Nitin Patel later elaborated that this park will initially manufacture helicopters, the requirement for which in India is massive (*see news item*). According to reports, Airbus has projected requirement for 900 acres for its own facilities plus an additional 1,000 acres for its suppliers, vendors and housing purposes.

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APPOINTMENTS

Air Marshal SB Deo is VCAS

Air Marshal SB Deo took over as Vice Chief of the Air Staff on 2 January 2017. He was commissioned as a fighter pilot in the IAF on 15 June 1979, is an alumnus of the National Defence Academy and the Defence Services Staff College, Wellington. He is a FCL (Fighter Combat Leader) and a 'Cat A' Qualified Flying Instructor with over 3,800 hours of operational and training flying, and was also Directing Staff at TACDE.

Air Marshal SB Deo has been AOC of a major fighter base, has commanded a MiG-21 Bison squadron and a Signals Unit, and was also Chief Operations Officer of a forward base. Prior to taking over as VCAS, he was AOC-in-C of Western Air Command (WAC), AOC-in-C Eastern Air Command (EAC), DG Air (Ops), AOC Cobra Group, AD Commander and Air I at HQ Central Air Command besides holding various staff appointments and working in Ops/Plans Directorates at Air HQ.

Lt Gen Sarath Chand is VCOAS

Lieutenant General Sarath Chand took over as Vice Chief of Army Staff on 13 January 2016, before which he was GOC-in-C, South Western Command. Commissioned into the Garhwal Rifles in June 1979, in his career spanning over 38 years he has served in all operational theatres and has participated in many active combat leadership roles at every stage of command, including in the Kashmir Valley and thereafter as GOC IV Corps in Assam.

Air Marshal C Harikumar is AOC-in-C WAC

Air Marshal C Harikumar took over as AOC-in-C, Western Air Command (WAC) on 1 January 2017. He was commissioned into the IAF in 1979, is a Qualified Flying Instructor and a Fighter Combat Leader, with over 3,300 hours of flying and having had instructional tenures at Fighter Training Wing (FTW), Tactics and Air Combat Development Establishment (TACDE) and College of Air Warfare (CAW). He has commanded a MiG-21 Squadron, the TACDE, and a frontline fighter base. His staff appointments include Ops 1A, Air-I at HQ WAC and Deputy Director Air Staff Inspection, Director Operations (Joint Planning) and Assistant Chief of the Air Staff Operations (Offensive) at Air HQ and Senior Air Staff Officer (SASO) at HQ South Western Air Command (SWAC). The Air Marshal was AOC-in-C Eastern Air Command (EAC) prior to his present appointment.

Air Marshal Anil Khosla is AOC-in-C Eastern Air Command

Air Marshal Anil Khosla has taken over as AOC-in-C, Eastern Air Command. Commissioned into the fighter stream of the Indian Air Force in December 1979, he has over 4,000 hours of accident free flying, mainly on variants of the Jaguar, MiG-21 and HJT-16 Kiran. He is an A2 category flying instructor and a fighter strike leader, and has stood first in the order of merit in various courses he has attended: the Flying Instructor Course, Fighter Strike Leaders Course, Junior Command Course and Staff Course.

The Air Marshal has vast instructional experience and has been Directing Staff at the Tactics and Combat Development Establishment (TACDE) and Flying Instructor School (FIS). He has commanded No. 6 Squadron 'Dragons' with the maritime strike Jaguar, and two frontline bases of the IAF at Jaisalmer and Ambala. He was AOC HQ Maritime Air Operations and AOC Commanding J&K Area.

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Air Marshal Sanjay Sharma takes over as Air Officer-In-Charge Maintenance

Air Marshal Sanjay Sharma assumed responsibilities of Air Officer-in-Charge Maintenance at Air Headquarters, New Delhi on 1 January 2017. Commissioned in the Aeronautical Engineering (Electronics) branch of IAF on 12 July 1979, he is an alumnus of the NDC, a graduate in Electronics Engineering from University of Indore, and post-graduate in Computer Science and Data Processing from IIT Kharagpur.

The Air Officer had held various important staff and field appointments, notably as Chief Technical Officer of THD-1955 Radar Stations, Senior Project Engineer (Radar) at the erstwhile RCPO, Director IACCS (Tech Planning), Director Signals (Air), Principal Director of IACCS, Assistant Chief of Air Staff (Signals & IT) at Air HQ, Deputy Senior Maintenance Staff Officer at HQ Maintenance Command, Assistant Chief of Air Staff (Maintenance and Planning) and Director General (Aircraft) at Air HQ. He has also commanded a major Communication Hub Centre and was deputed to Government of Botswana where he also set up the Technical Training Wing for their Air Defence Operations Centre.

Two Indian 'moonshots' in 2018

Two vastly different Indian teams are planning separate 'moonshots' in 2018, the first being an Indian Space Research Organisation (ISRO) effort, while the other is *TeamIndus*, a private start-up aiming to claim the Google Lunar XPrize (GLXP) and put Indian space businesses on the map. *TeamIndus* is led by Rahul Narayan, an IT entrepreneur and IIT-Delhi graduate, along with four co-founders: former IAF fighter pilot Samir Joshi (also a regular contributor to *Vayu*); investment banker Julius Amrit; advertising professional Dilip Chabria and aerospace engineer Indranil Chakrobarthy. The venture is the only Indian entry for the GLXP, which calls for teams to send privately funded robotic spacecraft to the Moon, travel 500 metres, and transmit high-definition video and images back to Earth. Participants are required to launch their spacecraft no later than 31 December 2017.

That deadline will put them ahead of the larger and better-funded ISRO Chandrayaan-2 project, which presently plans for an early-2018 launch and will see a robotic rover probe the lunar terrain for 14 Earth days. However, both missions will launch using ISRO launch vehicles. The 3,250 kg Chandrayaan-2 payload (around four times heavier than the TeamIndus payload) will be launched aboard ISRO's Geosynchronous Satellite Launch Vehicle (GSLV) Mk.II, while TeamIndus will launch using a Polar Satellite Launch Vehicle (PSLV), sharing space with fellow GLXP contestant *Team Hakuto* of Japan. The end-2017 launch timeframe has led to *TeamIndus* planning to land their craft on the moon on the morning of Republic Day 2018.

Alpha Design collaborate with ISRO for satellites

Alpha Design Technologies Pvt Ltd (ADTL), a Bengaluru-based manufacturer and technological services provider in India's defence and paramilitary markets, has contracted with the Indian Space Research Organisation (ISRO) for assembly, integration and testing of IRNSS (Indian Regional Navigation Satellite System) satellites. Over the next two years, with ISRO's support, Alpha will be investing in creating a modern satellite manufacturing, assembly, integration, testing and qualification facility, with a view to independently providing four to five satellites to ISRO.

Enter the Hawk-i

HAL rolled out the first indigenously upgraded Hawk Mk132, (the *Hawk*-i) on the eve of India's Republic Day. "This is the 100th Hawk aircraft produced at HAL and we are proud that it has *Make in India* mark. HAL had conceived a programme for indigenous upgradation of the Hawk Mk132 for achieving self-reliance and has successfully accomplished it", stated Mr T Suvarna Raju, CMD, HAL.

Upgrade of the Hawk AJT was assumed by HAL "so as to be independent in matters such as integration of new sub-systems or modifications, obsolescence management of avionics systems and to enhance the aircraft operational and training capabilities".

The Hawk-i supplants the earlier imported Mission Computer and Data Transfer Units with HAL-designed and developed systems. The new Mission Computer in the dual redundant configuration has additional capabilities such as Digital Map Generation (DMG) which provides improved situational awareness, while the Embedded Virtual Training System (EVTS) offers improved training capability over the existing system. The Hawk-i also provides secured voice communication and data link capability by integration of Softnet Radio and pilots can configure and select cockpit Human Machine Interface (HMI) for different aircraft platforms.

Navy issues RFI for 57 carrier-borne fighters

In mid-January 2017, the Indian Navy issued a Request For Information (RFI) for 57 Multi-Role Carrier Borne Fighters (MRCBF), indicating the Navy's aircraft carrier plans for the future. The RFI indicates that the MRCBF is to be day/night and all-weather capable, and will be employed for Air Defence (AD), Air to Surface Operations, Buddy Refuelling, Reconnaissance, and Electronic Warfare (EW). Instead of specifically requesting an aircraft that is both STOBAR- *and* CATOBAR-capable, the RFI simply asks for the certified mode of operation, and whether the other would be feasible with little to no modification. The document is generally exploratory in nature, seeking details of available fighters worldwide, in order to frame appropriate qualitative requirements to be issued with the eventual Request For Proposals (RFP).

Crucially, the RFI states that the acquisition process will be carried out under the Defence Procurement Procedures of 2016, despite a key chapter on strategic partnerships with nominated private sector industries still missing from this document. The RFI also indicates that technology transfer and licence production of the fighters in India will be preferred, and that aircraft deliveries are expected to commence within three years of contract signature, and be completed after a further three years.

Tejas LCA in R-Day 2017 Flypast

Inspite of inclement weather, the flypast over Rajpath on Republic Day 2017 consisted of 35 aircraft and included for the first time, indigenous Tejas LCA fighters and the Netra AEW&C aircraft, developed by the DRDO. Four Mi-17V5s in the lead were followed by four HAL Dhruv ALHs of Army Aviation and then the Netra, with formations of C-130J Hercules, Mi-35s, Jaguars, MiG-29, C-17s and Su-30MKIs following in quick order. The finale was a 'vertical Charlie' performed by a Sukhoi Su-30 which almost immediately disappeared into the grey sky.

PSLV-C36 launches RESOURCESAT-2A

In its thirty eighth flight (PSLV-C36), ISRO's Polar Satellite Launch Vehicle successfully launched the 1235 kg RESOURCESAT-2A Satellite on 7 December 2016 from Satish Dhawan Space Centre SHAR, Sriharikota. This is the thirty seventh consecutively successful mission of PSLV.

After PSLV-C36 lift-off at 10:25 am IST from the First Launch Pad with the ignition of the first stage, the subsequent important flight events, namely, strap-on ignitions and separations, first stage separation, second stage ignition, payload fairing separation, second stage separation, third stage ignition and separation, fourth stage ignition and cut-off, took place as planned. After a flight of 17 minutes 05 seconds, the vehicle achieved a polar Sun Synchronous Orbit of 824 km height inclined at an angle of 98.725 degree to the equator (very close to the intended orbit) and 47 seconds later, RESOURCESAT-2A was separated from the PSLV fourth stage.

After separation, the two solar arrays of RESOURCESAT-2A deployed automatically and ISRO's Telemetry, Tracking and Command Network (ISTRAC) at Bangalore took over control of the satellite. Later, the satellite was brought to its final operational configuration following which it began to provide imagery from its three cameras. The data sent by RESOURCESAT-2A will be useful for agricultural applications like crop area and crop production estimation, drought monitoring, soil mapping, cropping system analysis and farm advisories generation.

Like its predecessors RESOURCESAT-1 and 2, RESOURCESAT-2A has a unique 3-Tier imaging system with Advanced Wide Field Sensor (AWiFS), Linear Imaging Self Scanner-3 (LISS-3) and Linear Imaging Self Scanner-4 (LISS-4) cameras. The AWiFS provides images with a sampling of 56 metres, a swath of 740 km and a revisit of 5 days whereas the LISS-3 provides 23.5 metre sampled images with 141 km swath and a repitivity of 24 days. LISS-4 provides 5.8 metre sampled images with 70 km swath and a revisit of 5 days.

With this launch, the PSLV has yet again demonstrated its reliability. The total number of satellites launched by India's workhorse launch vehicle PSLV including the RESOURCESAT-2A has now reached 122, of which 43 are Indian and the remaining 79 are international.

PSLV remains the ISRO's versatile launch vehicle for launching multiple satellites in polar SSOs, Low Earth Orbits (LEO) as well as Geosynchronous Transfer Orbit (GTO) and sub GTO. With 36 successful launches, PSLV has emerged as the workhorse launch vehicle of ISRO and has been offered to launch satellites for international customers.

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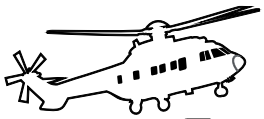

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The Transformation of HAL

VAYU Exclusive Interview with

Mr T Suvarna Raju, Chairman / MD Hindustan Aeronautics Limited

VAYU : As part of HAL's Platinum Jubilee celebrations, certain major milestones have been identified concerning projects currently in hand and the launch of new initiatives. These include the HTT- 40 basic turboprop trainer, Light Utility Helicopter (LUH), HAL turbofan and turboshaft engines, and establishment of a helicopter complex facility at Tumakuru. Kindly share the status of these programmes.

TSR: Basic trainer aircraft Hindustan Turbo Trainer-40 (HTT-40) has been developed with internal funding. The maiden flight of the first prototype (PT-1) took place in May 2016. Presently, PT-1 is under flight trials. Additionally, two more prototypes are being manufactured to speed up the flight trials and development process. The project is going on in full throttle as we aim to get the aircraft certified in 2018. After this series production would follow.

HAL has successfully carried out the first technical flight of prototype (PT-1) of LUH in September 2016. LUH PT-1 is currently under flight trials and HAL plans to build two more prototypes to accelerate the development in order to achieve certification by December 2017. Series production of the LUH would follow at the new facility coming up at Tumakuru near Bengaluru.

The design and development of a 25 kN turbofan engine (HTFE-25) is making good progress since the engine's inaugural run in December 2015. HAL has carried out more than 100 trial runs and also achieved engine run at 100% RPM. This engine can be used on trainer aircraft apart from business and executive jets.

Another engine currently being developed is 1200 kW turboshaft engine (HTSE-1200). The Design Concept Document has been prepared and released, with design optimisation and detail design

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analysis presently under progress. This engine can be used on three- to six-tonne helicopters.

VAYU: Management of the Tejas LCA Mk.I and Mk.IA production programme is now vested with HAL, which has or will have orders for 40 plus 83 aircraft. Please share status of some outstanding issues such as likely date for FOC and outstanding issues, delivery schedule of the balance 37 LCA Mk.Is, the new AESA radar, EW suite, and other systems identified for the Mk.IA, timeline for series production of the LCA Mk.IA, and so on.

TSR: The work on LCA Mk.I FOC activities pertaining to integration of weapons and the air-to-air fuelling probe, as well as envelope expansion is under progress and FOC is expected by December 2017.

HAL is working on ramping up production capacity from eight to 16 aircraft per annum. With increased levels of outsourcing and enhanced participation of Indian private industry, HAL will be able to speed up deliveries to cater to the present and future requirements.

No.45 Squadron with three aircraft is already operational at Bengaluru since July 2016, and it is planned to complete the order for 40 LCA Mk.Is by 2019-20.

LCA Mk.IA is an improved version that incorporates enhanced combat capabilities like AESA radar, air-to-air refueling,

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INSPIRED WORK

The first two series production LCAs at AFS Hindon during Air Force Day (photo : Angad Singh)

The Tejas LCA has entered service with the IAF, but FOC is not planned before end-2017 (photo: Angad Singh)

Self Protection Jammer (SPJ), and BVR missiles in addition to providing better maintainability features. The process of identification of new systems and their global OEMs is under progress. The development of this version is likely to be completed by the end of 2018. The series production will follow thereafter. Moving over to production of Mk.IA from Mk.I is expected to take place seamlessly.

VAYU: The Dhruv ALH is one of HAL's flagship products, yet has received little attention from the global market. With the Mk.III and Mk.IV variants now validated and in-production, what are the plans for a renewed sales push in the international market?

TSR: With well-established domestic production and the first squadrons of weaponised Dhruv helicopters already in service with the Indian armed forces, HAL now plans to take Dhruv ALH Mk.III and Mk.IV (weaponsied) variants forward and explore international market primarily in South East Asia and Africa. Civil certification of ALH Mk.III is underway and we believe that this will help in further penetrating the global market. The company has, however, already exported 13 ALH to international customers.

VAYU: Further developments based on the Dhruv platform have resulted in the Light Combat Helicopter (LCH) and, more recently, the single-engine Light Utility Helicopter (LUH). Please update us on these programmes, projected service entry dates, approximate numbers envisioned for production, and so on.

TSR: LCH is a very agile helicopter designed with stealth features, with over 850 flights carried out subsequent to the maiden flight in March 2010. Development of the LCH is complete and basic configuration was frozen in October 2015. The helicopter is presently undergoing weapon integration and weapon trials.

LCH has the distinction of being the first attack helicopter to land in Forward Bases at Siachen, a first for any helicopter in the world. LCH participated in IAF's *Iron Fist* firepower demonstration in 2016 and displayed rocket firing capabilities (*see Vayu III/2016*). HAL has now commenced the Limited Series Production (LSP) programme for LCH and the Defence Acquisition Council (DAC) has cleared procurement of 15 Limited Series Production

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The HAL Light Combat Helicopter will enter limited series production shortly (photo: Angad Singh)

helicopters. The initial order book for LCH is expected to be more than 150 helicopters across the Indian armed forces.

As mentioned earlier, HAL has successfully carried out the maiden flight of the first LUH prototype and plans to achieve certification by December 2017, following which series production would commence at Tumakuru. HAL expects an initial demand for over 200 LUH.

VAYU : HAL and BAE Systems are working on development of an Advanced Hawk trainer. What is the target market for such an aircraft and in what role (combat/light attack, purely training, or any other)? Has the IAF indicated interest in this project, or is it intended to essentially be an export-oriented programme?

TSR: HAL has signed an MoU with BAE Systems for development of Advanced Hawk aircraft and for maintenance solutions to support the Jaguar and Hawk fleets. Interactions between HAL and BAE Systems are under progress to work out a model for development of Advanced Hawk. The target market is likely to be both domestic as well as global. We expect IAF to evince interest after completion of some significant development work.

VAYU: There are reports that the Indian Government is considering an additional production line of one or more foreign fighter types. Has HAL been involved in deliberations relating to this endeavour, or in which way could the Company be involved in production, testing and certification if such a programme comes to fruition?

TSR: As of now, HAL is not involved in the deliberations relating to the manufacturing of foreign fighter aircraft in India.

VAYU : What is the status of the JV between HAL and Safran at Goa for servicing and support of helicopter engines?

TSR: A Joint Venture (JV) Company, Helicopter Engine MRO Pvt Ltd, between HAL and Safran Helicopter Engines, France was inaugurated by the Defence Minister on 23 October 2016 at Goa. To start with, the JV will provide Maintenance, Repair and Overhaul (MRO) services for Safran TM 333 2B2 and HAL Shakti engines installed on HAL-built helicopters operated by the Indian military.

HAL recently rolled out the 100th Indian-built Hawk Mk.132 fighter, incorporating a number of avionics upgrades (photo: HAL)

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VAYU: Discussions on the Indo-Russian Fifth Generation Fighter Aircraft (FGFA) project have been going on for several years. What are the envisaged next steps and when will the formal contracts for development/production be formalised?

TSR: The Preliminary Design Phase of FGFA is complete. Negotiations for R&D contract between Indian and Russian side is concluded and the final report submitted to the Chairman, Cost Negotiation Committee (CNC) for further processing. The development timeline would be 84 months after the contract is signed.

VAYU: HAL has launched a civil variant of the Do 228 light transport aircraft, which seems 'ideal' for India's regional air connectivity scheme. When is the first batch to be delivered, to whom, and with what initial objectives?

TSR: The Dornier 228, a 19-seater light transport aircraft, is expected to play a major role in the Government's Regional Connectivity Scheme (RCS) to bring Tier-II cities on the aviation map of the country. Market demand for the Do 228 is expected to be at least 200 aircraft and initial orders could be expected after the successful roll out of the first civil variant Do 228 aircraft by September 2017. The structural assembly facility for civil Do 228s at Kanpur Division was inaugurated by the Minister of State for Civil Aviation on 10 December 2016.

VAYU: HAL is pro-active in the Skill Development programme launched by the Government in the field of Aeronautics. Kindly share the key elements of this programme and how will it be embedded in the 'Make in India' initiative.

TSR: The 'Make in India' and 'Skill India' initiatives of the Government will play a big role in the development of aerospace and aviation sector in India. Taking the lead in supporting the Government's 'Skill India' mission, HAL actively participated and engaged maximum number of apprentices under the National Apprenticeship Promotion Scheme (NAPS). Towards this, Prime Minister Narendra Modi presented a cheque to HAL in Kanpur for playing a constructive role under NAPS at 'Kaushal Mahotsava' programme held in Kanpur on 19 December 2016.

Under the aegis of National Skill Development Council (NSDC), the HAL-promoted Aerospace and Aviation Sector Skill Council (AASSC) was established in Bengaluru in July 2015. The AASSC is also supported by the Society for Indian Aerospace Technology and Industries (SIATI) and Bangalore Chamber of Industry and Commerce (BCIC). The objective is to develop skilled manpower in the aerospace and aviation sectors. The Sector Skill Council is a Section-8 company as per Company Law, i.e. a non-profit organisation. The AASSC has an ambitious plan of skilling 400,000 young persons in the next ten years as well as to qualify more than 4,000 trainers by developing national occupational standards, facilitating training and assessment.

Further, toward supporting the 'Skill India' initiative of the Government, HAL has adopted six Industrial Training Institutes (ITIs) and plans to invest Rs 1.5 crore to upgrade their training infrastructure and improve the quality of training. HAL is also setting up a Centre of Excellence at the Technical Training Institute in Bengaluru to train the youth in cutting edge technologies like CNC programming and operations to meet industry requirements.

HAL and the Indian Institute of Science (IISc) have tied up to start the HAL-IISc Skill Development Centre at IISc's new campus at Challakere in

Chitradurga district, Karnataka. HAL is financing the infrastructure under CSR. The model facility will offer skill development programmes to the beneficiaries.

HAL and BEL are coming together to form Defence Innovation Research Organisation (DIRO) to create an ecosystem that fosters innovation and encourages technology development in defence by engaging R&D institutes, academia, industries, start-ups and even individual innovators.

VAYU: HAL is completing 2016 on a high note with a well-deserved recognition from professional institutions for excellence in management and leadership attributes. This is indicative of a positive transformation in HAL in coping up with the fast changing eco-system in the specialised area of aeronautics/aerospace. Kindly elucidate on how HAL plans to retain this pre-eminent position.

TSR: HAL is the largest Aerospace and Defence (A&D) Company in India. HAL has been playing a leading role in driving the growth of the A&D eco-system in the country while retaining its focus on the growth of the Company.

HAL is moving forward with a greater efficiency in the operations of the Company. HAL has increased the level of outsourcing to enhance the participation of private companies including MSMEs to develop a robust aerospace eco-system in the country.

This development of the eco-system is critical for HAL to transform itself from an end-to-end manufacturer to a major integrator. HAL would like to focus on the core activities of design and development of niche products – aircraft, helicopters, engines and other latest systems and create Intellectual Properties (IPs) essential for sustaining its leadership position in the Indian aerospace and defence industry.


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Agni-V: India's Iron Hand

On 26 December 2016, India's Inter Continental Ballistic Missile (ICBM) Agni-V was successfully test-fired for the fourth time by the Defence Research & Development Organisation (DRDO) from Launch Complex 4 of the Integrated Test Range (ITR) from Wheeler Island off the coast of Odhisha. The flight lasted around 19 minutes. The missile is usually programmed to attain an apogee of 600km prior to descent, while the third stage firing the Re-entry Vehicle (RV) separates at 6km/sec thereafter encountering the atmosphere at an altitude of 100km. The RV subsequently attained further acceleration due to gravity to record a speed of Mach 25+ and impacted the pre-designated target with "pin-point accuracy", within a few (reportedly single digit) metres of the designated target point around 2,500km away in the Indian Ocean. Although the exact range of Agni-V is classified, the road-mobile missile is comfortably expected to reach targets in excess of 7,000km if armed with a single 200kt nuclear warhead from secure launch points deep interior India. The missile was 'cold launched' from a hermetically sealed canister mounted on a Tractor-Erector-Launcher (TEL) ensuring rapid launch sequence, higher reliability, longer shelf life, less maintenance and enhanced mobility to ensure survival.

With a length of 17.5 metres, diameter of 2 metres and launch mass of around 50 tonnes, owing to extensive use of composites to reduce weight, the Agni-V is a three-stage solid fuelled missile with composite motor casing in the second and in the miniaturised third stage. Agni-V will incorporate advanced technologies involving ring laser gyroscope-based Micro Inertial Navigation System (MINS) and accelerometer for navigation and guidance further to be boosted by military grade precise signals from the Indo-Russian GLONASS satellite navigation system. Agni-V will also carry at least three Multiple Independently targetable Re-entry Vehicles (MIRV) payloads within its 1.5-metre diameter all carbon composite RV (capable of withstanding temperatures of up to 5,000degrees celsius) to deliver multiple manoeuvring warheads at different targets or on a single target to execute saturated strike to overwhelm enemy Ballistic Missile Defences (BMD). A sea launched variant with a length of less than 12 metres may be anticipated for ballistic missile armed nuclear powered submarines (SSBN) that may (in peacetime) double as Satellite Launch Vehicles (SLV) fired from proximity of the equator to put multiple satellites in geo-synchronous orbits. Agni-V is poised to emerge as India's standard ballistic missile to be put to mass production to for assured deterrence in the foreseeable future with the predecessors remaining in service until about 2018. The stunning accuracy consistently displayed by the Agni-V prototypes, along with extensive mobility and indigenous BMD will enable India for the first time to adopt a "limited deterrence" posture by adopting both counter force and counter value stance.

Finally, the measured response of major global powers in response to India's ICBM tests has affirmed India's position as a responsible nuclear weapons State with self-imposed non-proliferation obligations. These tests also eliminated China's long-time dream to dominate the Asian landmass Would the Indian scientific community conduct a of round of nuclear weapons tests to fine tune the thermonuclear devices to be mounted on Agni-V? An undertaking to sign Comprehensive Test Ban Treaty (CTBT) thereafter will certainly help in global acceptance.

Sayan Majumdar

India and the HAWK

The Indian Air Force's requirement for an advanced jet trainer (AJT) had its genesis in the La Fontaine Committee during the mid-1980s which urged the selection and induction of a suitable Stage III or lead in fighter trainer to bridge the gap in flying training between the benign HAL Kiran basic jet trainer and frontline operational fighters. After phase out of the HAL-built de Havilland Vampire T.55s which had served well in this role, the IAF perforce sent its young pilots straight from the Stage II Kirans to Mach 2 fighters, such 'fracture' in the training process being regarded as a serious deficiency. In the event, it took a torturous two decades to formalise the contract for BAE Hawk advanced jet trainers, the type having been selected after exhaustive evaluation, flight trials and industrial–commercial negotiations.

Finally, on 3 September 2003, the Cabinet Committee for Security (CCS) cleared acquisition of 66 Hawk AJTs for the Indian Air Force, 24 of them to be procured from BAE Systems in flyaway condition, the remaining 42 aircraft produced in India by Hindustan Aeronautics Limited under licence.

The Memorandum of Understanding (MOU) between the Governments of India and the UK was signed at South Block in New Delhi on 19 March 2004 "for the effective and uninterrupted implementation of the contracts regarding acquisition of 66 Hawk Advance Jet Trainers (AJTs) from BAE Systems and other equipment manufacturers of UK." Indian Defence Secretary Ajay Prasad signed the MOU on behalf of the Government of India while the British High Commissioner in India Sir Michael Arthur signed on behalf of the UK Government, covering "full support and cooperation for the supply as well as licence production of Hawk AJT for IAF from BAE Systems and other associated equipment manufacturers of the UK", as also facilitating agreements concerning licence production of the products and associated equipment and weapon systems for the Hawk of UK origin.

In April 2004, a Defence Consultative Group was established to monitor of transfer of technologies for the Hawk and indicative of the speed with which the programme unfolded, the first batch of IAF pilots selected for the new flying training programme were sent to Anglesey in Wales during July 2004 to begin advanced jet training with the Royal Air Force, which would go on till February 2008. In all, some 75 IAF pilots received training in batches at this busiest of RAF air bases.

The 'Hawk Interim Indian Flying Training', as the programme was called, comprised eight weeks of theory and simulators, 20 weeks of advanced flying, three weeks of tactical weapons simulation and 14 weeks of live tactical weapons training. The first batch of 6 IAF pilots graduated from RAF Valley on 23 May 2005 even as BAE Systems delivered the first 'made for India' Hawk Mk.132 advanced jet trainer. BAE Systems reported then that "the Indian programme is moving at a terrific pace; as well as HT001's first flight we have a number aircraft in final assembly, and have shipped the fuselages of additional aircraft that will be assembled by HAL in India in India. This is in addition to us managing the delivery of over 1,500 tonnes of raw material, 3,500 tools and around 15 million components to HAL in Bangalore" !

After flight acceptance tests, HT 001 was also used for development of key capabilities even as the first batch of IAF Hawks departed BAE Systems at Warton on 8 November 2007 for their destination, Air Force Station Bidar in northern Karnataka. Formal induction of the Hawk Mk.132s took place on 23 February 2008 in presence of then Defence Minister AK Antony.

Building the Hawk at Bangalore

As part of the Hawk for India programme, Hindustan Aeronautics Limited were contracted to build 42 Hawk Mk.132s, the order dated February 2005, following which some 300 personnel from Hindustan Aeronautics Ltd Bangalore were seconded to BAE at Brough for instruction and specialist techniques. In all, the Indian contract had 24 Hawk Mk.132 aircraft to be built in the UK, a further three supplied to HAL as major assemblies (fuselage, wings and empennage), and three more shipped to HAL in component form. The remaining 36 Hawks and their RR Adour Mk.871 turbofan engines were to be built in India, from raw materials.

The training programme began at the beginning of 2005, and was intensified during 2006 with 66 HAL personnel attached with BAE in the UK. Thereafter there was focus on middle management and engineers receiving their familiarisation training, and thereafter operations staff which gave them hands on training at Brough but also on the supply chain. The duration of the training, and the length of time spent at Brough, was determined by the level of training required for their specific role back at HAL Bangalore. This was the largest exercise of its type that has ever been conducted at Brough, and one of the most complex. It got even larger through 2007 with the additional arrival at Warton of Indian Air Force personnel comprising 97 mechanical/electrical technicians and 12 pilots, as well as three HAL test pilots.

In Phase I, BAE Systems supplied 3 unequipped fuselages and wings, kits of parts and accessories. The defined assemblies (alieron, flap, engine bay doors, under carriage doors and empennage) and removable role equipment (pylons, drop tanks and gun pods) were to be manufactured in HAL from raw materials, even as HAL would equipped the fuselage, wing, carry out system check and test fly the aircraft.

In Phase II, again involving 3 aircraft, BAE Systems supplied CKD (completely

knock down) kits for fuselage & wing and accessories to HAL who would then complete the aircraft leading to test flights.

In the third and last Phase (III) for 36 aircraft, BAE Systems supplied the raw materials and accessories to HAL, which would fabricate parts and assemble the fuselage, wing, and defined assemblies and role equipment, equip the aircraft and carry out system checks and test fly the completed aircraft.

There were several new technologies concerning the airframe including creep forming of wing and tailplane skins, mechanised forming of stretched acrylic of wind screen glass, metal and nomex braiding looms and much else.

First HAL-built Hawk

Even as the first BAE Systems Hawks flew into Bidar in mid-November 2007, the Government of India was negotiating for another batch of Hawks, 40 more such AJTs for the Indian Air Force plus 17 for the Indian Navy. The order was formalised in July 2010. While HAL was planned to complete manufacturing the initial batch of the 42 Hawks in 36 months – with the first aircraft scheduled to roll out in March 2008 – work on the additional 40 started from 2011-2012. Meanwhile, ten more UK-built (direct supply) Hawk Mk.132s were scheduled to be received by the IAF in mid-February 2008.

As per scheduled plans, Hawk production at HAL, divided into three phases, peaked during the second phase (starting end-2009) with HAL producing one aircraft every month during this phase, undoubtedly the most technically challenging since HAL concurrently indigenised a number of components and systems.

On 7 May 2008, the first HAL-built Hawk Mk.132 (A3621) made its maiden flight in Bangalore, piloted by Sqn Ldr (Retd) Baldev Singh, Executive Director and Chief Test Pilot (Fixed Wing). It was a few months later, on 14 August 2008, that the official flight was made, again by Sqn Ldr Baldev Singh. The flight lasted for

(Top, down): Hawk Mk.132s after completion at HAL's Aircraft Division, Bangalore; The IAF's 'Surya Kiran Aerobatic Team' (SKAT) is now flying Hawks; The Indian Navy operates Hawk Mk.132s from INS Dega, Visakhapatnam

15 minutes including some breathtaking aerobatics. Later, HAL Chairman Ashok K Baweja handed over documents of the aircraft to Chief of Air Staff Air Chief Marshal FH Major who stated that "Induction of Hawk into IAF will help us improve training tremendously."

Meanwhile, Air Force Station Bidar had been upgraded as the main operating base for the Hawk aircraft. Work services for upgradation included extension of both runways, construction of a new air traffic control complex, installation of nav-aids, labs and servicing facilities for the Hawk.

Two years later, on 28 July 2010, on occasion of the British Prime Minister's visit to HAL Bangalore, HAL signed a 'declaration' with the major UK partners, BAE Systems and Rolls Royce, "to further strengthen the scope of cooperation particularly in the areas of production of aircraft/engines, support/services for aircraft, engines and spares along with development of long term sustainable global business relationship".

The parties thereafter finalised contracts for an additional 57 Hawk Mk. 132s and their Adour Mk.871 powerplants for the IAF (40) and Navy (17) as follow-ons to the first tranche of 66 Hawks ordered in 2004.

On 25 November 2011, at a meeting of the Defence Acquisition Council (DAC), the Ministry cleared a proposal of the procurement of an additional 20 Hawk Mk.132 AJTs for the Indian Air Force. It was understood that the additional Hawks would also facilitate reformation of the Surya Kiran Aerobatic Team (SKAT) with the Hawk Mk.132.

In a seminal event, on 6 November 2013, the Indian Navy inducted the first three of 17 HAL-built BAE Systems Hawk Mk.132 advanced trainers, at Naval Air Station INS *Dega* (Visakhapatnam), the ceremony attended by various Flag Officers and senior officers of the Navy, including Chief of the Naval Staff, as well as senior management from HAL and representatives of BAE Systems and Rolls Royce.

The Hawk Mk.132 was initially operated by an Intensive Flying Training Unit. "The induction of this highly capable aircraft will bridge the gap for flying and weapons training of naval fighter pilots and also provide the *ab initio* naval pilots with an ideal platform to hone their skills before they graduate to flying high performance aircraft and carrier-based fighter jets".

The Advanced Hawk

In mid-2015, HAL and BAE Systems officially 'agreed' to explore the development of a 'Combat Hawk', incorporating leading edge slats in a bid to improve the aerodynamic performance of a new variant of this advance jet trainer. The 'Advanced Hawk', which is also sometimes referred to as the 'Combat Hawk', is being evolved to give this splendid aircraft light attack capability with precision-guided munitions.

The Hawk AJT already has advanced avionics, including digital cockpit displays that enable trainee pilots to carry out precise navigation, the employment of sensors including radar, as also to fire weapons. The Hawk Mk.132 has seven wing stations for mounting weapons and reconnaissance equipment, and weapons need to be integrated with the avionics of the aircraft. Transforming the Mk.132 into a 'Combat Hawk' would also involve carriage of air-to-air and air-to-ground missiles, rockets and bombs.

According to defence analysts, the Combat Hawk would endow considerable air support capability to the Indian Air Force especially in counter insurgency tasks as also as a light attack fighter in the high mountain areas of northern India.

Prof. Prodyut Das mulls over the Falcon, Gripen, Tejas

"Opportunities in Crisis"

Ceremonial IOCs apart, the date of the effective IOC (sic) of the LCA Tejas continues to be uncertain. The current bets are on for June 2017 but only the congenitally gullible will believe this. Worn out by overuse, these occasions usually mark not progress but the retirement of someone who had joined the project as a young man. The latest date for the LCA Mk.1A given by the DRDO Chief is of significance.The Mark 1A's first flight is given as 2018 with completion of testing by 2021 and production starting from 2022. These dates, normal for a new project, indicates comprehensive redesign is required to make a Mk.1 into a Mk.1A.

New readers are referred to *Vayu I/2015*.

Going entirely by common sense, the Tejas Mk.1 aircraft seems unfit for induction. The truth is that this project has done more to reduce the frontline strength of the IAF than the two attempts by the Pakistan Air Force. Precisely for this reason if the LCA Mk.1 was even half decent, the IAF would be glad to have the forty Mk.1s if only to work out its SOPs whilst waiting for the Mk.1A. This was what the RAF did with the less than satisfactory Hunter Mk.1.This has not happened. The *official* rumour, as Sir Humphrey Appleby of *Yes Minister* would say, is that the production is constrained by supply of composite parts produced by NAL. It will be noted that three limited *series* (italics mine) production aircraft, LSPs 3, 4 and 5 were turned out within a period of six months in 2010. So if the IOC 1 was not merely ceremonial we should have had at least 36 aircraft by now, admittedly hand built and admittedly below par, but it would have given us something better than the Hawk as a close support aircraft in an emergency. The fact that five years after an IOC, the production rate is one aircraft per year and dates continue to remain uncertain indicates that :

- The IOCs etc are *Nautankis*, a form of rural folk drama usually noted for unpredictable outcomes and non-following of scripts.
- The aircraft has severe technical flaws and is unfit for service. No one can clear it for mass production.
- Aircraft debugging is not some form of black magic. Is the problem cultural? I mention this because I have noticed this in the CAD/CAE industry. When things do not come out right, the people know what needs to be done but lack the faith and the energy to put it right on the actual product.
- Or worst, were the delays condoned so that things slid to the imports route ?

Below is my unkind but perhaps not unreasonable assessment of the situation.

The Prognosis

The story is told of a RAF twin engine light bomber of WWII whose engine speed governor required "a look at" every fifteen hours. Unfortunately the cowling had for aerodynamic reasons not been provided with a suitable access panel and it was in one piece so the entire cowling had to be taken off. To take it off, the propeller had to be taken off first. In the LCA where the customer was kept at arm's length to "fast track the project" (official 'pomp' in the '90s, if I remember right) serviceability related issues would be quite likely.

There have also been reports of the LCA's engine /inlet mismatch. This would be more serious at take off – at high speed the ram effect would help – so we have an engine which is giving less than max. thrust at take off and MTOW from standard fighter fields would be degraded. Recall that the LCA has operated so far from civil airfields. Does this tie up with the extraordinary keenness at this 'pre-IOC' stage (I am sorry but I do not believe that No.45 Squadron is yet for real) for an in-flight refueling capability? That way one could take off with a lower load and then tank up on fuel once airborne. Sounds ridiculous? So do *two* IOCs! It *is* disappointing that we could not get the intake reasonably right first time : Intake sizing is *not* rocket science. The shame and the pity is that this problem was sat on for *sixteen years*!

If the above prognosis is somewhat right, this is what needs to be done:

- Presuming individual systems are reliably working, the Mk.1 airframe has to be stripped skin inwards of every system and frame and redesigned for weight improvement, inlet modification and ease of packaging and servicing. This last means that on the ramp the armourers do not get in the way of re-fuellers and so on. The ballast weight has to be reduced to the minimum, perhaps less than 30 kg.
- The airframe will then have to be *re-engineered* for ease of production, re stressed and tested for fatigue.

All this will take about two years to get together and may be another two years to test so we are looking at four years from the start date before we can even think of producing LCA Mk.1A in series. Assuming that the new government had put pressure on by end of 2014, we are looking at 2018 for the first series production Mk.1 and Dr. Christopher's dates are right for the Mk.1A. Even though the Mk.1A's dates are breathing down the neck of the Mk.1's, going directly to the Mk.1A is not the best because we still do not know all the "gremlins" in the aircraft until it gets into some kind of normal service-assuming of course that the Mk.1 can receive its FOC by 2018/2019.

The Direct Competition

Without doubt the biggest "enemy" to this project has been its progenitor organisation

Lockheed-Martin's F-16 Block 70 is being vigorously marketed to the IAF ...

... as is Saab's Gripen E New Generation multi-role fighter, both types very much in the competition

which by delays and "unreliable" promises has (and that is putting it very mildly) now caused a condition where two very good generically similar aircraft are on offer to be licence-built in India. If we have two hundred Gripen Es or Super Falcons, then the LCA will slip into the "why bother" category. To avoid this eventuality we need firm and sustained political action. The order for eighty three Mk.1As is welcome but it should be followed by larger orders for more specialist versions.

The LCA and the MMRCA : Drawing the boundaries

There is little point in discussing capabilities of the MMRCA contenders. In a way they are as with the Howitzers, as alike as peas in a pod. My view is that the even the most painstaking selection could be subject to parliamentary criticism or one could get the dumbest AC2 to pick a name out a hat and that choice could be logically defended! These are products which are competing in peace but must compete in anger – and win. They are designed for certain scenarios, mainly North European wars where they will fly in an environment of densely packed, sophisticated as well as well trained and equipped opposition in appalling weather , with low or non- existent daylight conditions. But, their MMRCAs are *obscenely* over-equipped for our kind of war. In North European winter, compared to India, all flying is night/dusk flying with Radar, RLG, IN, GPS, IR and GPWS all *essential*, and needed even in peace just to get safely back to base : bailing out over the Tundra in winter from fuel starvation due to navigation error or CFiT (controlled flight into terrain) in low visibility is just not an alternative.

The question to be repeatedly asked and carefully is : are the MMRCA-types too over equipped for India's wars? The Israelis were delighted with the performance of their Mirage IIICJs in the 1967 war but being smart, when they reordered these as the Mirage 5, they sensibly deleted the Cyrano search radar, and the Matra 530 missile and took the cheaper limited capability Aida ranging radar it being correctly argued that the better radar did not give *significant* advantage over the Sinai desert and BVR missiles made even less sense at low level. The Israelis used such weight savings to increase payload range and also reduce costs.

Continuous value analysis must be at heart of the LCA philosophy and is the key to its survival as a contender. Only someone with cloven feet will argue that all the abbreviations AESA, BVR, MAWS, ECM, ESM, IRST, NV, etc do add to capabilities but these capabilities exact a price in terms of cost and vulnerability. *More* is not always *better* and in the LCA, intelligent frugality has to be enforced if the concept is to succeed. The "pro capability" argument that much of such equipment is often carried externally and the aircraft is only plumbed for the eventually, is evasive. The 'plumbing' - cables, wires, brackets, pipes, power sources, clamps, the additional airframe space and pylons–all add to the weight. Northrop did a study in the 1960s and found that each kg of electronics added five kg to the final empty weight. This figure is still very true. In the F-16/ Gripen E, these capacity enhancers have in time increased empty weight by about three tons, with significant effect on handling and costs. External carriage, be it a LANTIRN or towed decoy or a BVRM, adds to the aircraft's weight and the drag enroute and then over the battlefield.

Further from War, further from reality

Just after the '71 war, during planning for the Ajeet, HAL received a request from Air HQ to modify the ISIS F124 sight. The focus was on simplicity and all features such as gyro tracking, ranging, span settings, were to be deleted, with the sight becoming almost a simple collimating one–just one step short of the proverbial chewing gum on the windscreen. Just as we (at least my friend dear V. Pramod) had worked the mods out, the IAF came back with a request for getting the radar ranging input back in. Further change requests followed with uncanny timings until by about 1975, we were back with the original ISIS F124 configuration!

Table 1

Type	W/L	T/W	ID/T	FF
MiG-21 Bis	354	0.87	0.39	0.27
Model A	393	1.05	0.244	0.29
Model F	533	0.86	0.36	0.256
Degradation	0.33	0.13	0.16	0.12

The need for *all round* vision even at the expense of performance was hard learned in WWII but quickly lost in peace. Study the Mustang P-51A- P51B-P51C-P 51D ; F-86 Sabre ; F-100 Super Sabre ; F-4 Phantom F-15, F-35 canopy styles with time as example and one will see two cycles of the same mistake ! Further studies since then leads me to believe that the further one is away from combat experience, the sweeter sounds the Salesman. The F-16's case is worth recounting because it reinforces two truths :

- The further one gets away from war the closer one gets to 'Marketing as above' ;
- Although everyone loves a fighter, its main job finally is *Offensive Air Support.*

After Vietnam, when the *swing role* (although they had not thought up of this jargon at that time) Phantom II fared badly against the specialised MiG-21, the USAF went in for the "not a pound for air-to-ground" approach. This resulted in the F-15 which was far too expensive and so a cheaper solution was also desired as a supplement. The F-16 started life as the Light Weight Fighter (LWF), an aircraft using only one of the F-15s engines. The first F-16 weighed only 6,857 kilos (which justifies my view that the much smaller and lower-powered LCA's empty weight should be around 5,300kilos), used a 108.57 kN F100 engine and with two Sidewinders and 3162 kilos of fuel and pilot weighed in at 10,952 kilos giving a clean combat T/W of 1.02. It was sensibly equipped : a AN/APG 66 radar, Marconi HUD, FBW, SKN 2400 INS, Sperry CDAC, AN/ALR-69 RWR, UHF, VHF, ILS,TACAN in addition to all the usual avionics. Today's F-16 has put on around three tons of weight, can handle all the current abbreviations that can be mounted on its pylons and there has been no growth in its wing area although the engine now is bigger at 131 kN to

The MiG-35 was derived from the MiG-29M, with the Indian Air Force as the initial customer

36 Rafales have been ordered for the Indian Air Force

help attract IR missiles like Stingers and its clones. It is certainly a more versatile fighter but is it a more "sensible" fighter? Do we need all those night/low daylight/ long distance navigation, ferry capabilities necessary in the Global policing role for *all* those platforms? The AESA is essential for the Western scenario because one may have to fight without ground based radar coverage. But is it true for us? If we ape the West, we will get a "barn door" and not a fighter and in fewer numbers because of the tremendous costs !

Table 1 on the previous page is illustrative. It compares an early model A of a bestselling contemporary fighter with gun armament and two IR CCMs and the latest standard model F of the same aircraft but plumbed for all the updates and with enhanced capability and carrying full internal fuel, two IR CCMs and four BVRs.

The following is to be noted:

- The model F is a better "all rounder" but inferior in performance to the MiG-21 which was its original "to beat" target.
- The combined increase of Wing loading and Power loading means handling at cruise and landing speeds will be noticeably inferior.
- Despite being re-engined with a substantially more powerful engine, the T/W ratio has gone down by 18%. The noteworthy point is the same "philosophers" had earlier expounded the dire necessity about 1:1 T/W.
- ID/T is a poor man's index of Specific Excess Power and gives the amount of engine thrust that is washed away by the induced drag as the aircraft executes a 3 g turn at 350 kts. The reduction is significant. In reality it will be worse

The Typhoon could still be in the competition for new 'twin-engined' fighters?

because the drag of those BVRs and the increase in Cd_o has not been factored in. Is it any wonder that BVRs have often been jettisoned before entering combat? Then why carry them on marginal platforms?. Let some bigger platform with 'power surplus' like the Su-30MKI carry these.

- FF is the fuel fraction and gives the amount of max internal fuel divided by the engine thrust in kgs and is an indicator of combat persistence i.e. one who has to break off first, is usually the loser. The later model has 12% less persistence. In reality, allowing for standard reserves, the case would be far worse.

Keep the L in the LCA

In the '80s the Soviets did not hesitate to use four different types, viz MiG-21, Su-17, MiG-27/23 and the Su-24 just to meet the battlefield air needs of their *Frontovaiya Aviatsya*. The IAF has wisely gone in, like the Soviets, for a combination of LCA, MMRCA and the Su-30MKI. Let us reap the benefits of this stratification to the maximum ! The LCA has a niche position and can survive only if it stays within its *Lakshman Rekha* of being a limited capability fighter which is its *raison de etre*. Whether the fighter should be small and adequate or large and versatile for a penalty of 50% increase in IR/ visual signature is a question that only pilots climbing 1,500 m AGL in bright sunshine to make rocket attacks will have to take a call on. In an LCA, something has to go : range, payload or equipment levels.

The Beastie and the Beasts

Below is a personal assessment of the original MMRCA contenders and why the selection went the way it did.

The MiG-29 was my personal favourite. Having worked in technology transfer projects of various Soviet military engineering projects, I am admittedly biased but I found them robust : in war the Su-7 never missed a sortie due to unreliability and was enormously sensible and effective. The MiG-29 SMT/K (a.k.a. MiG-35) should have won on grounds of commonality (with the Navy's MiG-29K), familiarity, just right equipment fit, great performance and (one hopes) lower prices. The fact it was not chosen means that there was sustained move to disengage from Russia.

The F-16/Gripen E : These pose the most direct threat as they are generically similar i.e. single-engine, single-seat, to the Tejas, particularly the Tejas Mk.2. However these aircraft have put on between two and three tonnes since their inception and are no longer the cheerful things they were though they remain very effective for global wars. We need something smaller and simpler. Again in their non selection, the reason was probably political. Having gingerly disengaged from the Russian Bear it is hardly wise to rush into the arms of the American Grizzly! Both these countries are large enough to twist our arms! The Gripen too, like the Viggen earlier, is "sanctionable". I am also leery of buying any single engine warplane from the West. These things cost half their weight in gold and single engines have a five time higher attrition rate than twins in peacetime. Still, if I had to choose, I would take the Gripen.

The Rafale is the median aircraft in the Table 2. France is economically manageable and hopefully cannot "bully" us. They have been reliable suppliers – in the Falklands Conflict, they supplied equipment impartially to both sides and go by principles which must have also played a role. It is an excellent choice and role wise, a good replacement for the Jaguars and the MiG-23 BNs. I am sure we shall buy some more.

The Typhoon was another excellent contender and could have been chosen but was dropped for commercial reasons. The project is multi-national but there is no truth in the rumour that it was feared that after the next World Cup, Italy may invade Germany and then where would we be ?!

The Boeing F/A-18 Super Hornet could well be under consideration for the IAF – and Navy

The Super Hornet is also excellent but falls nearer to the Su-30 and is more oriented to strike roles (and suffers from being American).

All these aircraft claim to have been "blooded" in combat but that is sales jargon. Fighting poorly trained North African Armed Forces which are often racked by internal dissensions or Jihadi militias out to conquer the world is really not even a half decent proving ground. Successes and achievements in these "colonial" wars are irrelevant, specially regarding advanced equipment effectiveness. I am still waiting for results of PGMs and BVRs in a professional war. The Chinese or the Pakistan Armed Forces are professional forces and the results in North Africa are of little relevance on what we may expect from our two neighbours they are a completely different league to the current mayhem being played at in North Africa and West Asia

Loose formation of Tejas LCAs at an Aero India Show

Size is actually "armour"

In the last "one and a half front war" of 1971, even with the PAF partially crippled by disaffected Bengali personnel, we lost about 75 combat aircraft owing to all causes. Of these, about sixty were involved in OAS (offensive air support).Nineteen of the very capable Su-7s were lost to cheap AAA whilst about fifteen Hunters fell equally to AAA (and fighters) in this role. The MiG-21 losses were just two to AAA in OAS roles and the little Gnat, still unreliable and hobbled by the lack of 250 kg. bombs which confined it to RP attacks, did a very creditable job being visually and aurally stealthy. Of over three hundred OAS Gnat sorties, only one was hit by a few bullets but even that recovered to base. There is strong correlation between size and losses. These lessons are still relevant. The latest F-16 and the Gripens are like Hunters of the past and the Tejas is the Gnat of the present. Technology could really improve the Gnat's lacunae of range/payload and safety to very acceptable levels. It should be debugged and more specialised OAS versions for strict VFR roles should be developed and ordered after the present orders for eighty three LCA Mk.1 As.

The need for numbers

The final argument for the Tejas is really a question of numbers and, therefore, costs. *Numbers* are also *capability*. Given the improvement in Air Defence technologies since '71, we must prepare for a combat loss in a "one and a half front war" of around one hundred and twenty aircraft in the *first two weeks*. If you do not believe this, ask the Israelis about the Yom Kippur War losses. Post the 1973 War's decimation, the Israeli IDFAF took ten years to recover their former arrogant elan. They also doubled the number of their combat squadrons from eleven to twenty. The lessons are stark and clear. One hundred and twenty aircraft equal about seven squadron's worth. To remain a viable fighting force without any resupply from Uncle (Sam!) as was available to the Israelis, we must have an OAS element alone of about twenty five squadrons i.e. about four hundred aircraft with a suitable establishment in pilots, of whom we should expect a loss of about fifty, so as to sustain the force for re-growth ! A large Indian Air Force is definitely needed. Economics limits the MMRCA's numbers while technology limits the LCA but the balance must swing towards the latter. We must divide the Tejas into 'cheap' specialist variants and strictly leave the multi role function to the MMRCA and the Su-30MKI which is superb in its own way.

IAF Su-30MKI during a recent 'Red Flag' Exercise in the United States

The LCA variants

The Western philosophy of "one size fits all" does not fit India. We can neither afford nor design 'swing role' aircraft and they do not make sense for us. The LCA must be developed in specialist variants to keep them within the 5,300-6,000 kg empty weight limits..

In the following narrative, the definitions are as follows: LCA Mk.1 is the "as is" aircraft and has a dry empty weight of 6,600 kgs. The LCA Mk.1A is the lightened and aerodynamically refined version with a weight of 5,300 kilos. The LCA Mk.1N is a Mk.1A with a cranked delta wing with a span of 10 mts, an area of 40 sq. mts and an AR of 2.5. (*Ref.LCA 5400/2.5* in *Vayu I/2015*)

The LCA Mk.1 This seems to be pretty much a "gone case" and we should induct these in the same spirit as the Hunter F.1 : a good aircraft for extended field trials of the other systems, perhaps just the forty or until the LCA Mk.1A catches up. Reduction in empty weight and with its intake sorted out, it will be a fair strike aircraft. Historically it would be like the Hurricane Mk IIB : a good fighter–bomber but wary when it ran into the Hayabusa on the Burma front. **40 units.**

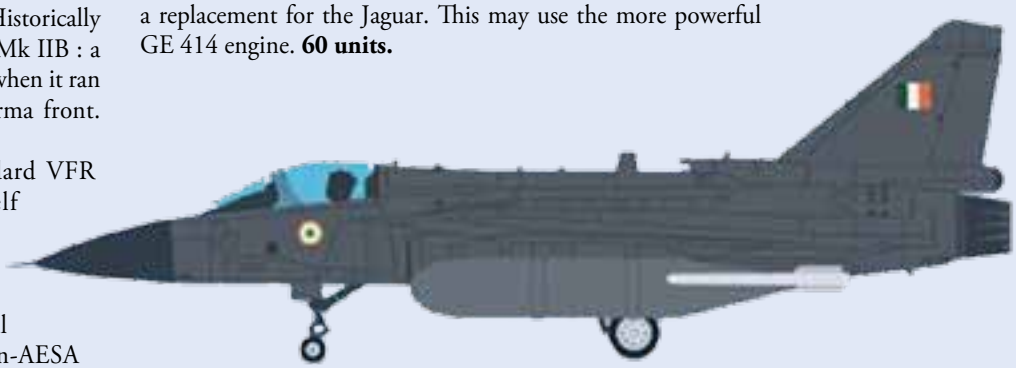
The LCA Mk.1A Standard VFR light attack aircraft with self defence capability for short range i.e. 180 n.m.at low level radius of action with a three ton war load. Typical equipment fit would be a non-AESA radar, VHF, UHF, TACAN, IFF, Autopilot, HUD, INS, FBW, RWR, HMD, HUMS and CCM. No BVR, FR, NV capability. **100 units.**

LCA Mk.1B As above but optimised for VFR close support with armoured cockpit and 'get home' systems plus GSh 30-2 cannon. This is technically like a 'tailless' miniaturised MiG-27 replacement with better handling and a much

smaller aircraft. This would be the ideal time to introduce 'cranked wing" version. (see *Vayu* I/2015) **200 units.**

LCA Mk.1C are the 40 Mk1s to be withdrawn and rebuilt to 1C standards with cranked wing to serve as VFR escort fighters with BVR capabilities including AESA radar and flying top cover for Mk.1. **40+20 units**

LCA Mk.1N Two seat night capable aircraft for LLXC intruder roles. LANTIRN, NVG compatible cockpits, Conformal tanks. This would be a replacement for the Jaguar. This may use the more powerful GE 414 engine. **60 units.**



LCA Navy during night trials

LCA LIFT/Maritime As in Mk.1N but specialised with capability of carrying Anti Shipping missiles. Trainer is fully equipped including BVR and Night capabilities but with reduced energy and speed performance. **60+60 units.**

LCA F414 Mk.2 In theory, thanks to having half the wing loading of the Sea Harrier FRS Mk.1, the LCA Mk.1A with the F404 should actually be doing better than the Sea Harrier provided its empty weight is held to around 5,500 kilos. This weight target is not unreasonable technically because the Sea Harrier FRS Mk.1 weighs 5,891 empty and is a bigger aeroplane with a heavier engine. If the NLCA is not doing better than the Sea Harrier it is because of the overweight airframe and the inlet/engine mismatch problem. The risk with the F414 solution is that the additional weight of the engine, systems, fuel, structure, airframe mods means fairly extensive redesign of a tailless planform which is more "touchy" of such things.

LCA Tejas carrying out high-altitude trials at Leh (Photo : Rana)

Tejas at Aero India 2015

Another point to watch out for is that the LCA Mk.1 has a record low aspect ratio (AR) of 1.8. This makes it very critical of any weight overruns. The configurations shown in open source is that wing area has been added in a manner to further reduce AR. This is a risky path to disappointment should weight control supervision fall below "outstanding" levels.

The best we can do is to try the cranked wing of the Mk.1C (10 mts span, 40 sq.mts. wing area, AR 2.5) and perhaps with folding tips to assist stowage and an empty weight of less than 5,600kgs.

The above break up is to illustrate the need to stay within weight limits and

optimise the LCA's advantages of good performance at low costs. If one needs all the capabilities in one platform which is difficult to justify, then we are looking at something in the shape of the Rafale and beyond.

Fighting and 'their' War

The only *certainty* that Western military planners are certain about the next war is that *it will not be over home territory*. The distance from peacetime base, the weather, the terrain, the type of targets, the quality and numbers of bases to be prepared to operate from and indeed the whole logistics of warfare, is really an unknown. The equipment therefore is of "ready for anything and for any eventuality" comprehensiveness with a high degree of independence from ground /base located systems. Despite complex and expensive equipment, one necessarily pays the price in terms of complexity and reduced performance to have such 'swing role' capability.

By contrast the Indian military planner actually *knows* everything about the war he is going to fight : targets, distances, routes, terrains, tactics, the bases to use, the extent of situational awareness support from AWACS and ADGES systems, the likely time of the year for war and, in some cases, even the profiles and personalities of the opponents.

Table 2

Type	U We	UDL	UDL/UWe	U vol	U thrust
LCA Mk.1	1.18	0.87	0.74	0.96	1
LCA Mk.1A	1	1	1	1	1
Gripen E	1.42	1.3	0.92	1.24	1.3
F-16	1.81	1.63	1.1	1.44	1.46
Rafale C	1.85	2.0	1.08	1.85	2.25
Typhoon	2.03	1.84	0.91	1.85	2.25
MiG-29	1.98	1.34	0.82	1.95	2.6
Super Hornet	2.65	2.3	0.87	2.46	2.9
Sukhoi Su-30	3.36	2.31	0.7	4.15	4.25

It cannot be that these two completely different tactical situations will require the same and identical level of equipment. The Light Combat Aircraft fits into this scenario like a glove whereas for the Western commander it is a non starter from the word 'go'.

As India's equipment can be simpler, we can use smaller platforms as the LCA. Given the above tactical situation, we must persist with the introduction of a large number of LCA Mk1As and its variants as the of the IAF's operational strength.

The possibility of manufacturing 200 F-16s/Gripen Es is obviously a direct threat to the LCA. These fine aircraft are too well equipped, too expensive, too general purpose and may be just too sophisticated to be economical in our scenario and budget. The prospect of exports is merely sales talk.

Since the 1960s, the IAF has handled a polyglot variety of aircraft with much panache. The IAF's decision to use three categories of fighters – LCA/MMRCA/Su-30MKI–is extremely sound though with development of the LCA, the MMRCA category could be of lesser numerical importance in our threat scenario. We should consider a mix of 30+4+10 squadrons mix of those respective types.

Given the inherent limitations of the LCA concept, we must develop role specific variants for our air superiority/ OAS/Night and Maritime roles. Trying to do it all in one airframe is foredoomed.

To make it simple

Reference Table 2: U We is empty weight unitised using the LCA Mk.1A's weight of 5400 kgs as the *unit*. It can be used to compare costs also by factoring approx $17,000/kg as the asking price for current Western equipment. The LCA in established production should cost at the rate of $ 6000-8000/kg.

UDL is the unitised disposable load and is the difference between empty and MTO weights reduced by 500 kgs to allow for pilot, parachutes, hydraulic fluids etc. This indicates how much more the type carries compared to the LCA Mk.1A's unit of approx 6,500 kgs. It indicates how much more payload range the type has compared to the LCA Mk.1A.

The UDL/We gives how much offensive capability one is getting per kilo of aircraft weight. "Bang per buck" *is* an appropriate slang!

UTV, the unified target volume, compares the visual signature of the aircraft and is also the index of the aircraft's vulnerability to AAA and is based on the Span x Length x Height of the aircraft compared to those of the LCA's.

UT is the unified thrust and compares the type's installed max thrust with the LCA's. It is being used as an index of the IR signature of the aircraft.

So, what do these figures indicate?

- The re-engineered LCA Mk.1A will be an effective solution comparable to or better than many others. Unpardonable delays have happened because such delays were condoned in the past by the Establishment.
- If we are forced by politics to go in for the F-16/Gripen we should go for the simpler 'tailored' versions for major part of the fleet – and may be Block 60 or Gripen C for just three or four units.
- The Su-30's large visual and IR signature behoves that it should be only for the air dominance role where its UDL/UWe gives a very formidable performance even when carrying its entire ordnance including BVRs. It would be a disaster at low level roles which will be repeating history of the Su-7.
- There is little to choose between the various MMRCA contenders in terms of cost effectiveness *in our scenario.* The Rafale selection is very good as its supply is reliable, it is a twin and is sufficiently differentiated between the LCA and the Su-30MKI. We may need some more.
- For a one and half-front war, we will need an OAS component of 25 squadrons. The MMRCA contenders are unsuitable, uneconomical and an unproven solution for this role as *we* fight it. We need to look at a production of around six hundred role specific LCAs over the next decade. The cost of these six hundred aircraft will be less than two hundred of any of the MMRCA types.
- The LCA's engineering problems require a different approach than hitherto. The LCA and its variants, well re-engineered, offer an economical but effective solution to our essentially 'defensive' or 'non-policing' scenario. We cannot afford to accept the more glamorous Western concepts. We need a large core force of LCAs – far beyond the eighty three Mk.1As.

Watch this space!

Thunder vs Tejas: Dogfight over the Sub-Continent

The Sino-Pak JF-17 Thunder (top) and the Tejas LCA (below) are essentially similar in their intended roles and performance. The Thunder, however, has got off to a good start operationally (with over 100 in service) while the Tejas is some way away from front-line squadron service. An actual fly-off competition between the two types will be fascinating but since this is unlikely in the near future, a future issue of Vayu will attempt a neutral review

Back from the Brink

HTT-40 PT-1 in flight at HAL Bangalore (photo: Deb Rana)

HAL's HTT-40 Comes Good

Hindustan Aeronautics Limited (HAL) has doggedly pursued development of an indigenous turboprop basic trainer for decades, inspite of indifference and perhaps even some opposition. The lead HTT-40 prototype (PT-1) made its maiden flight in May 2016 and is set to meet its targets as envisaged by its young and dynamic programme managers. Angad Singh reviews the journey !

While the HTT-40 has actually only been in development since 2009, its genesis can be traced back to the 1980s. In 1984, the same year that the piston-engine HPT-32 Deepak trainer entered service with the Indian Air Force, HAL had already modified and flown the type with a 420 shp Allison 250-B17D turboprop in place of the 260 shp Lycoming AEIO-540 reciprocating engine. Despite improved performance characteristics over the basic HPT-32, there was no official interest in this internal project, and it was shelved in the late 1980s with only two prototypes built.

Meanwhile, having realised that the HPT-32 would soon be outmoded, the Indian Air Force issued an Air Staff Target (AST 203) for a tandem seat Basic Turboprop Trainer (BTT) – also in 1984! This led to development of the stillborn (and not very well known) HTT-35 trainer, the spiritual progenitor of today's HTT-40. A full-scale mock-up of the HTT-35 was unveiled at the first Bangalore air show, Avia India 1993 (*see Vayu I/1994*), at which event HAL officials noted that the turboprop trainer was to replace the HPT-32 *and* HJT-16 Kiran in the IAF's future flying training plans. The programme was intended to produce a tandem seat, glass cockpit aircraft, powered by either a Pratt & Whitney Canada PT6 or Garrett AiResearch (now Honeywell) TPE331 turboprop engine. The HTT-35 shared a number of similarities with today's HTT-40, including provision for under-wing hard points to carry a range of munitions and sensors.

At the time, HAL anticipated government clearance for full-scale development by mid-1994, and planned for first flight by 1996. A Preliminary Design Plan (PDP) for the new BTT, calling for a modest commitment of Rs 4.77 crore, had already been submitted in July 1993, and the IAF was expected to order around 150 of the type to replace some 200-odd Deepaks and Kirans in service.

Instead, the HTT-35 project was quietly shelved around 1995 for reasons unknown. An attempted revival of the

An HTT-34 at the 1985 Paris Air Show (photo: Fred Willemsen)

programme a decade later, in February 2004, also came to naught, and the IAF proceeded to soldier on with the HPT-32 until 2009, and HAL's attentions were diverted to the *de novo* Intermediate Jet Trainer (IJT) programme, which resulted in the problematic HJT-36 Sitara that is yet to enter service. The question of a turboprop trainer for the IAF remained unanswered until the uncharacteristically rapid procurement of Pilatus PC-7 Mk.IIs in May 2012, the type having been selected less than a year earlier, in June 2011.

The New BTA Saga

Around 2009 it became apparent that flight safety issues plaguing the HPT-32 would not be easily or quickly resolved. HAL was confident in its ability to design and develop a tandem-seat turboprop trainer – the HTT-40 – from scratch to replace the troubled HPT-32. However, by June 2009, in the interest of compressing timelines, the Company issued a Request For Information (RFI) to global OEMs, seeking to adapt an existing in-service Basic Trainer Aircraft (BTA) to the IAF's specific needs. At the time, HAL anticipated a domestic market of approximately 200 aircraft. The requirements spelled out in the RFI were modest – not much more ambitious than the HTT-35 from two decades prior – calling for a fully aerobatic sub-3-tonne aircraft with a range greater than 1,000 km, ceiling of around 6,000 m, +6/-3 g limits, and low-level maximum speed of around 425 km/h. The cockpit was intended to have a contemporary part- or all-glass configuration, with pressurisation, air conditioning, on-board oxygen generation and zero-zero ejection seats. The requirements also called for a 10,000-hour/30 year total technical life for the airframe.

Then, a fatal crash of the HPT-32 in July 2009 upended everything. The IAF grounded this aircraft type the following month, bringing the first stage of Air Force flying training to a grinding halt, and kicking off an urgent replacement programme. Through its service life, the HPT-32 had claimed 19 lives in 17 accidents – a tragic record over a few hundred thousand flight hours accumulated over more than two decades of operation, but not unusual over the lifetime of a training aircraft. However, it was the large number of in-flight failures and incidents that had over time reduced the Air Force's confidence in the safety of the type and contributed to its eventual grounding.

In December 2009, the IAF issued Request For Proposals (RFP) for an 'off-the-shelf' procurement of 75 turboprop-powered basic trainers, plus options, against a total projected requirement of 181 BTAs. Thereafter, things moved rapidly, and field trials commenced in September 2010. Five companies came forward with proposals and sent aircraft to Jamnagar for trials. These were Hawker Beechcraft with their T-6C Texan II, Korea Aerospace Industries (KAI) with the KT-1 Woongbi, EADS (now Airbus Defence and Space) with the PZL-130TC-II Orlik, Pilatus with the PC-7 Mk.II, and Grob with the G 120TP. Field evaluation reports were submitted by December that year, only a year after the RFP had been issued, and commercial bids of the shortlisted contenders – Beechcraft, Pilatus and KAI – were opened in May 2011. A month later, Pilatus was announced as the lowest technically qualified bidder (L-1).

There followed a period of contract negotiations and also protests from the two losing bidders, with the Koreans objecting particularly strenuously. However, less than a year after the PC-7 Mk.II was selected, the Cabinet Committee on Security (CCS) approved the 557 million Swiss franc (approximately Rs 3,600 crore) contract,

which was then signed in May 2012. The swiftness with which the entire process was conducted – less than three years from RFP to contract signature – raised the eyebrows of observers the world over, accustomed as they were to decades-long Indian procurements proceeding in fits and starts.

However, this uncharacteristic pace also placed HAL in the unenviable position of attempting to fulfil a trainer requirement that was now being met by a developed, certified and in-service aircraft being procured off-the-shelf. HAL's plans to develop their own aircraft had been thwarted by the direct purchase RFP in December 2009, forcing the Company to go back to the drawing board and develop the HTT-40 in-house, from scratch.

Still, preliminary design of HAL's trainer was already complete around the time that the PC-7 Mk.II was contracted for in 2012, but detailed design and further programme progress was held up by a disagreement between the IAF, HAL and the MoD on whether development of a new trainer was required at all. This spat boiled over and became public at Aero India 2013.

Even as the IAF's first Pilatus PC-7 Mk.II landed for static display at the 2013 edition of the Bangalore air show, HAL took the wraps off an HTT-40 mock-up at that very Show and expressed confidence that the aircraft would not only fully meet the IAF's requirements, but would be competitive with any contemporary trainer from around the world (*see Vayu II/2013*). Then-CMD HAL, Dr RK Tyagi, said at Yelahanka that "most of the preliminary design, including configuration studies and sizing, cockpit layout and wind tunnel model testing have been completed... any cost comparison with other basic trainers should be on the basis of life cycle costs, including maintenance support for the next 30 years, in which HAL will be competitive."

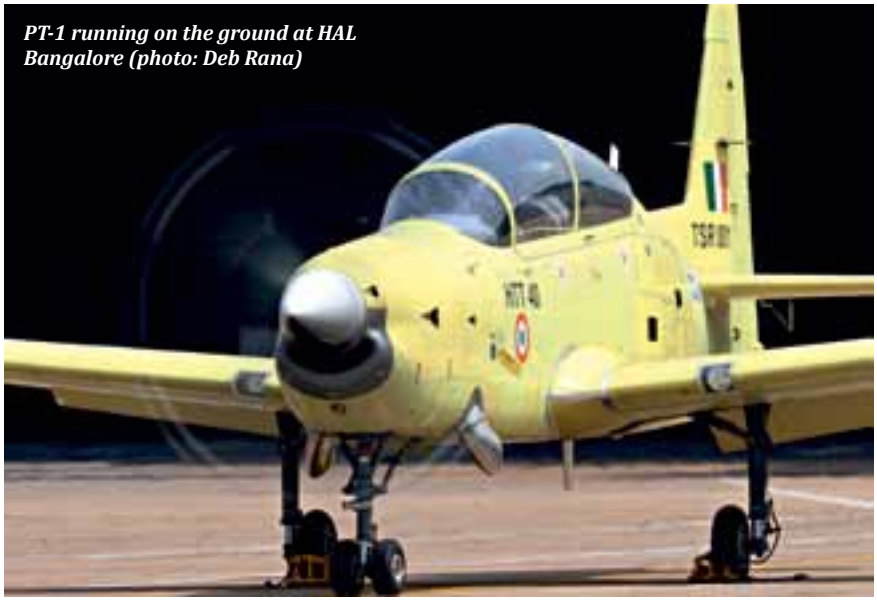
Contrary to that claim, then-Chief of the Air Staff, Air Chief Marshal Norman Browne, stated at the show that the IAF would prefer to operate a single BTA type, and recommended follow-on procurement of additional PC-7 Mk.IIs to meet the IAF's entire 181-aircraft BTA requirement. Defence Minister AK Antony was not demonstrably supportive of the indigenous trainer either. The Indian Air Force was now set to begin receiving the PC-7 Mk.II in quantity and commence Stage I training on the type, and the Service expressed satisfaction with the aircraft and associated training systems. The CAS was leery not only of having to wait for HAL to complete development of the HTT-40 and field the aircraft, but also of the additional capital and revenue costs associated with inducting and operating a second type of basic trainer. "We have the Pilatus PC-7," said Air Chief Marshal Browne. "It's a proven aircraft. The project HAL plans is from scratch. Our indications are that the costs will be too high. There is no need for all this."

Going It Alone

In August 2013 HAL attempted to sidestep the impasse by allocating some Rs 150 crore of internal funds to continue with the HTT-40 programme. The MoD expressed cautious support for the in-country development of a BTA, but refused to take a firm stand either on procurement of additional PC-7 Mk.IIs (under the 38-aircraft option clause of the 2012 contract) or on committing to the HTT-40 to meet the remainder of the IAF's BTA requirement, now reduced to 106 aircraft.

In 2014, HAL decided to increase internal funding for the HTT-40 project to Rs 350 crore, and the detailed design phase (described by HAL as the bulk of the overall design effort) was in full swing. The Company's confidence in – and perseverance with – the project was rewarded in February 2015, when the MoD cleared HAL to complete development of the HTT-40, with an anticipated order of some 70 aircraft. The production run, although lower than the 106 aircraft originally hoped for (and well below the initial 200-aircraft assessment from 2009), was assessed as being economically viable. The reduction in volume was attributed to taking up the PC-7 Mk.II contract option

Digital model of the HTT-40 (source: HAL)



PT-1 running on the ground at HAL Bangalore (photo: Deb Rana)

for 38 additional aircraft in March 2015. However, no formal agreement to that effect has been signed to date, and the option clause from the original contract was to expire in May 2015. It remains to be seen whether additional PC-7 Mk.IIs will be procured at all, and thus the HTT-40's production run may in fact see an increase based on IAF requirements alone.

In any event, fabrication of parts for the first prototype had already commenced in 2014, and by May 2015 the detailed design phase was complete, along with the forward fuselage of the first prototype (PT-1). In June 2015, the rear fuselage was completed, and both halves were then coupled in July. The control surfaces were complete by October 2015, and the first Honeywell TPE331-12B engine was delivered that same month. The end of October brought more welcome news, when the Defence Acquisition Council once again reviewed the HTT-40 programme and HAL was directed to continue work on the programme while "adhering to strict timelines". Additional milestones for the programme followed in short order: the wings were delivered in November 2015 and the engine was installed the following month. By the end of 2015, the HTT-40 had nearly completed the transition from the drawing board to the runway.

PT-1 (tail number TSR-001) was formally rolled out at the Aircraft Research and Development Centre (ARDC) in Bangalore on 2 February 2016 (*see Vayu II/2016*) to much fanfare. Progress thereafter was rapid, with ground runs of the engine commencing less than a fortnight later on 15 February. In fact, HAL carried out some 40 ground runs in the span of a week, in collaboration with the engine OEM, Honeywell. Intake recovery factor after these tests was reported at 99.1%!

The aircraft commenced low-speed taxi trials in March 2016, before transitioning to high-speed taxi trials in early May. Finally, on 31 May 2016, PT-1 took to the air for the first time, carrying out a 30-minute test flight with Gp Capt (retd) C Subramaniam at the controls. Less than a month later, the aircraft flew in the presence of Defence Minister Manohar Parrikar, who highlighted the fact that this programme was being run by the youngest project and design team ever, with an average age of around 30 years. He remarked that "the young team has taken a calculated risk and have flown the aircraft within one year and kept their assurance. The indigenous content on HTT-40 is close to 80 per cent. Almost 50 per cent of the components are manufactured by private players and MSMEs of the Indian aerospace ecosystem." Parrikar also reserved special praise for Project Manager Prashantsingh Bhadoria for seeing the programme through its many hurdles.

The Road Ahead

The flight test campaign for the HTT-40 programme is expected to involve around 300 flights, shared across three prototypes. HAL estimates that each test aircraft will fly around 6 sorties a month, which means PT-1 will have completed in excess of 50 test flights by Aero India 2017. PT-2 will join the test effort in February 2017, followed by PT-3 in December. HAL will therefore be conducting 18 test flights per month across all three aircraft from January 2018 onward.

In addition, HAL will build two static test specimens for a range of ground tests as also fatigue testing of the airframe. With this cumulative air-and-ground testing effort, the Company expects to achieve Initial Operating Clearance (IOC) by end-2018.

The final prototypes will be as close to production standard as possible, and the jigs and tooling from the prototype phase itself are configured to be nearly production-ready as well, all of which should lead to rapid commencement of volume production after IOC. HAL's Aircraft Division in Bangalore has been identified as the production agency

Defence Minister Manohar Parrikar in the cockpit of PT-1, as Project Manager Prashantsingh Bhadoria looks on

HTT-40 PT-1 taking off (photo: Deb Rana)

for the HTT-40, and is already closely involved with the ARDC development team as well as all proposed sub-contractors for the programme.

It is evident that lessons from past HAL programmes – both licence production and indigenous development – are being applied to the HTT-40, including a roadmap for future development of the type in a range of roles, such as light attack and ISR. A Detailed Project Report is yet to be sanctioned, which in turn has held up formal orders from the IAF, but given the pace of progress since HAL first began talking about the HTT-40 at Aero India 2013, the future of this aircraft is all but assured.

Project Manager Prashantsingh Bhadoria attributes this to the proactive team at HAL that "kind of fought for survival" through the travails of the past and has "now made a comeback at Aero India 2017" after the very public disagreements on view at Aero India 2013. "The project enjoyed the unprecedented support of the Defence Minister himself, who reviewed the project every quarter, ensured that the tempo stayed up, and reposed great faith in the HTT-40 team. In turn, the team had promised him that they would fly the aircraft within a year of design completion, and they kept their word when they made the maiden flight on 31 May 2016."

PT-1 coming in to land (photo: Deb Rana)

Saab bets on India

The Swedish defence firm hopes a marquee deal to locally produce new-generation Gripen fighters in India will secure a sustainable future for the company. Angad Singh reports from Sweden.

Air power and industrial power are two sides of the same coin, according to Mats Palmberg, VP Industrial Partnerships, at Saab's Aeronautics business area. Saab has a specific approach to delivering 'air power,' and it is banking on this to secure orders from the Indian government to build its new Gripen E multirole fighter in large numbers in India. There are three "cornerstones" to Saab's offer for India – sovereignty, independence, and sustainment – or "protecting your nation, on your own terms," says Palmberg.

Saab's "willingness to share" is at the core of these elements, and Palmberg is keen "to link the two countries to create a relationship that goes beyond buyer-seller or even industrial cooperation." Echoing statements made earlier by Saab India head Jan Widerström, Palmberg reiterates a now-common Saab talking point – the company wants to be here (in India) "for the next 100 years." A massive Gripen order, leading to the type forming backbone of the IAF's light fighter force, would open the door to the sort of sustained technical-industrial cooperation that could see this century-long ambition become a reality.

This plan to link the two countries and "create a relationship that goes beyond buyer-seller or even industrial cooperation" has already seen some groundwork laid with Saab's significant footprint in India. Palmberg pointed out that Tech Mahindra in Hyderabad have contributed to the development effort for the Gripen E. Saab is also working closely with a number of Indian industrial houses such as the Kalyani Group and Tata Sons.

Gripen NG Demo (39-7) with RBS-15, SDBs and Meteor

The Pitch

"Never underestimate Swedish engineers – they do rocket science on a piece of cloth!" laughs Lars Tossman, Saab's VP and Head of Airborne Surveillance Systems, Business Area Surveillance. This is said with a smile, but Tossman's point could be crucial to Saab's offer versus other competitors. Saab has developed – and therefore controls – nearly all the high technology elements that are a part of the current- and next-generation Gripen product families. Company officials stress that none of these key technologies are subject to restrictive USA-style export controls. Not only does this bode well for local production of the Gripen, but also for what Saab sees as the natural follow-on: development of the fifth-generation Advanced Medium Combat Aircraft (AMCA).

Saab's plan, described and refined multiple times since it was first formally articulated at Defexpo in Goa in 2016 is deceptively simple. An 'Indian Aircraft Company' (currently bearing the placeholder moniker 'INAC') will be established as "a centre of gravity for Gripen 'Make in India.'" This will be a Saab-controlled entity (or at least is planned as such), and will cover everything relating to design, production and in-service support for the fighter. Saab believes that indigenous capability centres on these three elements: design and development of platforms or weapons, domestic manufacture, and comprehensive in-service support. However, this capability can only be sustained and nurtured if constant innovation and new technology are implemented as growth drivers. Key to this is competent indigenous programme management and system integration capability. Importantly, it is not incumbent only on the development/production entity (in this case, INAC) to provide this sustainment – the customer must be closely and constantly involved to ensure long-term success of such a plan. In addition, training and skill development will be a key focus area for Saab as INAC ramps up, and Saab hopes that INAC will be able to replicate the close military-industry-academia framework that has allowed Sweden to maintain its competitive defence industry for so long.

INAC will be a focal point for the building of an Indian aerospace ecosystem, and yet it "will be beyond India – part of the global Gripen industrial system." Readying large volumes of trained manpower not just for INAC but also for the myriad planned programme sub-contractors is seen as all-important for leveraging the Company's Indian footprint to benefit the business worldwide.

Moreover, far from considering Saab control of INAC as a drawback, Palmberg deems it evidence of the Swedish company's "commitment to India," demonstrating that the Company is "serious about partnering India for the long term."

Production of the Gripen for India, however, will commence with a "dedicated Indian Gripen line" at Saab's Linköping facility. This will involve Indian tooling, parts and sub-assemblies as far as possible, and will see Indian workers trained 'on the job' on a live production line. The intent, similar to the Brazilian Gripen programme, is to leverage established Saab experience in production, quality assurance, logistics, and so on, while training a core cadre of Indians to absorb this experience and return with it to INAC in India. Simultaneously, infrastructure for INAC will start being set up in India, and suppliers will begin to be cultivated for the Gripen.

Once the INAC facility is running, all design, development and production will move to India – this is anticipated around 3-5 years after the programme gets underway.

The initial development effort in India and for India will include addition of India-specific weapons, sensors and avionics as may be required, as well as charting a course for future development of the Gripen E, which Saab is confident has significant growth potential. Broad-based cooperation on these areas and the overall production, certification, testing and sustainment of the Gripen will see competencies grow to support new programmes. Saab is clear that their vision for a 'Make in India' Gripen programme is not simply to address the IAF's force structure issues that will emerge over the coming decade, but to translate the growth of INAC's knowledge base and associated domestic industrial ecosystem to development and fielding of a next-generation fighter.

Gripen E 39-9 under assembly at Linköping in September 2016

"Share and co-operate is the Saab way"

"In our view it's definitely more than make. It's about design, develop, produce, maintain and innovate," says Palmberg. Saab is looking to be increasingly global, and feels it is natural to look farther afield for partners that would form an integral part of a "global industrial system." The Company develops capabilities for partners not simply by sharing data and blueprints, but by ensuring competency in underlying technology and know-how, then nurturing the ability to sustain and further develop this knowledge to be leveraged for later requirements.

"This is part of our DNA, how we grow our business," emphasises Palmberg. "Partnership, growth and commitment" are essential to Saab's future, and indeed have been a key element of the Company's past. Sharing technology is central to fuelling growth in a partnership such as that envisaged with India. "It must be a win-win, or why bother?" states Palmberg seriously.

INAC would be the first step toward a long-term commitment based on sound business practices, an ecosystem geared toward building and sustaining a range of aerospace capabilities, and an industrial and strategic relationship that would form the building blocks for future programmes. Saab highlights the benefits of a long-term partnership: not only does it offer eighty years of aerospace knowledge and experience, this know-how is unique, shaped by Sweden's historically fierce

Gripen C/D fuselages at Linköping

insistence on geo-political neutrality, and the direction of the Group's majority stakeholders, the powerful and influential Wallenberg family.

Sweden's Cold War position, sandwiched in between NATO and the USSR, led to a number of ground-breaking innovations that received little public recognition in those secretive times. The 1960s-vintage Viggen, for instance, pioneered the use of canard foreplanes, was the first to employ integrated circuits for its on-board computers, and perhaps most famously, became the first datalinked fighter system in the world after an upgrade in the 1980s. A long record of such innovation has allowed Saab to remain competitive throughout its 80-year history in the face of constantly evolving global and regional security situations, and it is precisely this culture of innovation led to Gripen "breaking the cost-capability curve," and allowed the Swedish military to field a fourth-generation replacement for the Viggen even with a drastically reduced budget. This is why Palmberg feels any prospective partner would benefit from a relationship with Saab that goes much beyond products or simple licence manufacture.

Traditional production at the customer side of a military procurement programme tends to be "build to print" licence manufacture, according to Matti Olsson, Saab's Head of Strategy and Business Development, Production. Saab, he says, asked how it might be possible to deliver better value for both the customer *and* Saab itself. The answer to this question led to an approach that underpins the Company's current model, implemented in South Africa, Thailand, and – at a much larger scale – Brazil. Saab is now pursuing partnerships with prospective customers, "leveraging expertise and knowledge from both sides of the relationship." The customer grows a relevant domestic industry and Saab grows its business. "Win-win," says Olsson!

Making the Gripen E

Olsson went on to detail some of the innovations Saab has brought to bear that have enabled tight control over development and production costs and schedules for the Gripen programme – both legacy and next generation.

One of the key strengths at Saab is the Company's highly trained workforce, and the productivity per worker. Nowhere is this more important than on the factory floor, where Olsson revealed just how much can be gained by streamlining roles in production. In the 1980s, says Olsson, Saab was "like any manufacturing company in the world," with large quality teams and departments focused on quality assurance/quality control (QA/QC). Periodic quality testing was essential, but added to production cost and time. In the 1980s the Company began thinking about a solution that would maintain or exceed existing QA/QC standards, but make production quicker and cheaper.

Gripen C/D nose sections awaiting integration

Self-assessed QA was the answer, and allowed them to meet the competing goals of maintaining high standards, lowering costs and shortening time spent in production. Today, QA training is part of production training for Saab workers. If a worker is certified to perform a task, they are certified to perform quality control for that task. For minor parts and assemblies, it is truly self-certified QA, while for larger and more complex processes, workers on the production line conduct QC for each other. Transitioning to this combined production and QA process has allowed Saab to drastically reduce manpower costs associated with fighter construction, and yielded significant reductions in time taken to build aircraft as well.

For the Gripen E, Saab had to try and achieve similar cost and time savings not only for production, but most crucially for development of the new fighter. In an increasingly competitive global market and with budget restrictions in the Company's home market, there was simply no room for traditional methods – delays could result in competing platforms eating into possible Gripen sales, while excessive development costs would drive aircraft unit costs too high and also impact the Company's own finances.

"Design – industrialisation – production," says Matti Olsson, is a process that cannot be escaped in developing a fighter, or any similar industrial product. Production or design by themselves provide limited value, he believes, with true capability being the ability to translate ideas effectively into production. In the past, this capability was usually manifested at the middle stage – the ability to industrialise an idea and put it into production. However, there was room for innovation and effort to be made across the entire process, and coming up with a combined solution for this was an important victory for the Gripen E development effort.

As recently as a decade ago, design teams at aircraft companies first made blueprints. These were translated to production documents, which were used for actual production on the factory floor. Then, much later in the process, maintenance people would transform the blueprints and production documents to technical manuals for sustainment and support. This led to many (disparate) documents for the same product.

Saab changed that for the Gripen E. Today at Saab only one digital model is used from concept, to design, to industrialisation, to production and finally to certification/support. This is 'Model Based Definition'

Gripen C/D rear fuselage being assembled in a jig – subtle differences are visible when compared to the Gripen E rear fuselage pictured to the right

39-10 rear fuselage under assembly in a jig at Saab's Linköping facility

(MBD), and it has been instrumental in meeting Saab's goals for the Gripen E programme. By incorporating all inputs into one combined process, instead of bringing them in at different stages, Saab dramatically reduced cost, risk and time. This not only streamlines design and development, but also helps the production effort, with every jig and station on the factory equipped with a computer providing workers ready access to specific steps in the correct order and with the required procedures (*see photos*). Furthermore, by keeping maintainers in the loop from day one, the design can take into account the needs and requirements of one of the most important elements of fielding and supporting a combat asset, ensuring there are no surprises out on the flight line during actual operations. Engine replacement, for example, takes no more than half an hour with an experienced crew of technicians.

The expertise built up around MBD during the Gripen E effort is a significant element of Saab's collaboration with Boeing on the US Air Force's T-X supersonic Lead-In Fighter Trainer (LIFT) programme, which saw the two companies design, develop and fly their first aircraft in a little over three years. This ability in designing from scratch, as well as experience in 'system of systems' integration is one of the centrepieces of Saab's Gripen proposal for India.

In addition, Olsson noted Saab's existing ability to cultivate and nurture sub-contractors to create an aerospace manufacturing ecosystem. Saab controls or owns most of the production technology on the Gripen, even if it does not physically produce parts and assemblies in-house (described as "capability, not capacity" by Olsson). This means Saab is able to decide what amount of low-level production is to be done on-site and what is to be sub-contracted, which usually results in a healthy number of partners and suppliers. In India, Saab expects indigenous support and maintenance capability to involve local industry because of the dispersed nature of operations, and proposes that INAC will have a largely supervisory role in this aspect.

Meanwhile, Saab is pursuing newer production technologies and consciously eschewing outmoded ones. For instance, the Gripen C/D involved heavy press forging for certain high-strength metallic parts. This meant either owning and operating an expensive hydraulic press (with forging pressures upwards of 10,000 tonnes) or sub-contracting low volumes to third parties. Neither option is cost- or time-effective. The Gripen E was able avoid using these forgings, replacing them with a combination of different materials and engineering solutions. 'Soft joint' technology eliminated

The second Gripen E (39-9) under assembly

heavy bulkhead joins between fuselage and wing elements. Instead the joints are 'dovetail' style making them less complex, lighter, yet as strong. This also increased internal fuel capacity, utilising volume freed up by the absence of large bulkheads.

Another relatively new manufacturing innovation Saab has incorporated into certain areas of the Gripen E (such as parts of the radar cooling system) is additive manufacturing (i.e. '3D printing').

Similar modern improvements are applied on the software front, something that Saab feels is key to separating the Gripen E from legacy fourth generation fighters. Lars Sjöberg, Head of Research and Design at Saab Aeronautics, pointed out that in today's digital world, computational power drives current and future development. While engines and aerodynamics "are bound by physics and improvements are broadly linear," computational improvements are a "major opportunity area." He cited *Moore's Law*, an axiom named after Intel co-founder Gordon Moore, who predicted (accurately) in 1975 that that the number of transistors in a dense integrated circuit would double approximately every two years. Saab's Distributed Integrated Modular Avionics (DIMA) architecture is designed to take advantage of this phenomenon by allowing for nearly seamless development, addition, or modification of capabilities by enabling rapid hardware and software iteration. DIMA on the Gripen separates flight critical hardware and software from tactical functionality, essentially acting as 'gatekeeper' between aircraft flight characteristics and safety, and the imperatives of improving tactical capabilities within ever-compressing schedules.

DIMA also means that hardware itself is modular, with almost every hardware element being a Line Replaceable Unit (LRU), allowing these to be replaced without having to re-qualify and re-certify the entire platform. This approach gives the Gripen E tremendous capability from the outset, but more importantly, makes continuous rapid upgrades throughout its service life much easier.

This, says Sjöberg, makes the Gripen E "a fighter that is highly adaptable to change" and this philosophy "will be indigenised and applied for future Gripen upgrades and future new fighter development" in India, should the fighter be selected to equip the Indian Air Force.

Flying and Fighting

To understand why the Gripen E is the "fighter for today and tomorrow," one needs to "start with legacy," says Mikael Olsson, a former Swedish Air Force pilot, who has been a test pilot with Saab since 2014. The Draken and Viggen "were designed to stay in the air," which meant that had to be maintained by conscripts and operated with small logistical footprints. However, he clarifies, "they had different variants for different tasks -- Gripen is truly multirole." Olsson would know, as he flew the Viggen extensively before converting to Gripen for test and evaluation. He then took the fighter to Italy for operations over Libya in 2011, as part of *Operation Unified Protector*, the NATO operation enforcing United Nations Security Council resolutions 1970 and 1973 concerning the Libyan Civil War.

The Gripen itself "is easy to fly" according to Olsson, with a 9 g-capable airframe, carefree handling, on-board oxygen generation, stores sensing system, and all the other contemporary features that are more or less *de rigueur* on any modern fighter. A combat air patrol sortie with air-to-air missiles and no external tanks can be flown out to 900 km with 100 minutes

Programme Update

39-8 in taxi trials at Linköping in December (photo: Saab)

At Saab's Linköping facility in October 2016, during *Vayu's* visit, the first Gripen E (aircraft 39-8) was being readied for first flight, the second aircraft (39-9) was under final assembly, with wings and fuselage mated (*see photos*), while the first sub-assemblies for the third aircraft (39-10) were under production (*see rear fuselage photo*).

Since then, 39-8 has been 'powered on,' extensively tested on the ground, and has commenced taxi trials in December 2016 (test pilot Marcus Wandt was at the controls for the first taxi). First flight is expected in the second quarter of 2017, with Saab electing to fully qualify the avionics and software before taking to the air.

Gripen E engine testing at Linköping (photo: Saab)

of 'loiter time' in the Gripen E, he states. At the end of the day, however, "fighters need to provide air power," says Olsson. Air power, in his assessment, is made up of three elements: combat performance, availability and affordability (acquisition *and* sustainment). "Any one of these things can make or break a fighter programme," he asserts firmly.

With the Gripen E, combat performance is ensured by the combination of sensors, defensive aids, and weaponry integrated or planned for the type. Olsson highlights sensor performance and fusion, stating that "Situational Awareness (SA) is key to winning a fight" and that the Gripen E will have "tremendous SA and decision support." In terms of availability and affordability, all Gripen variants have been designed for the Swedish philosophy of operations; with high Mean Time Between Failures (MTBF) and low Mean Time To Repair (MTTR), translating to good mission-capable rates, quick turnarounds, and very little time spent on maintenance – whether scheduled or otherwise. The Gripen E's MBD development approach improves on this, with maintenance personnel involved in the design of the aircraft from the outset.

All this translates to a tactically relevant capability available as needed by a force commander, in greater quantity.

[All photos by the author unless otherwise noted]

Udan Khatola

'Ude Desh Ka Aam Naagrik'

The Regional (Air) Connectivity Scheme – by another Name!

On 21 October 2016 two decades after the demise of Vayudoot, India's first and thus far only regional/commuter/third level airline, the Ministry of Civil Aviation took yet another step towards "making flying a reality for the small town common man", with Civil Aviation Minister P Ashok Gajapathi Raju launching the Ministry's much awaited Regional Connectivity Scheme UDAN in New Delhi. This time, however, it was to be an innovative scheme "to develop the regional aviation market, a market-based mechanism in which airlines bid for seat subsidies. This first-of-its-kind scheme globally will create affordable yet economically viable and profitable flights on regional routes so that flying becomes affordable to the common man even in small towns." Enter the UDAN.

Mr Raju expressed the hope that first flight under the scheme would be able to take off by January 2017 and said that the scheme had been prepared after a lot of stakeholder consultations and called for support "from all players to make it a success". Also speaking on the occasion Minister of State for Civil Aviation Jayant Sinha said that objective of the scheme was *Ude Desh Ka Aam Naagrik (UDAN)* stating that this scheme would ensure "affordability, connectivity, growth and development, provide a win-win situation for all stakeholders, citizens would get the benefit of affordability, connectivity and more jobs". While the Centre would be able to expand the regional air connectivity and market, State governments would reap the benefit of development of remote areas, enhanced trade and commerce and expansion of tourism. For incumbent airlines there was "the promise of new routes and more passengers while for and start-up airlines there is the opportunity of new, scalable business. Airport operators will also see their business expanding as would original equipment manufacturers. "UDAN envisages providing air connectivity to un-served or under-served airports of the country through revival of existing air strips and airports. The scheme would be active for a period of 10 years."

Jagson Airlines Dornier 228 at Kulu

Devil is in the Detail

As per the Ministry, "UDAN is a market-based model to develop regional connectivity and invites interested airline and helicopter operators to start operations on hitherto un-connected routes by submitting proposals to the Implementing Agency. The operators could seek Viability Gap Funding (VGF) apart from getting various concessions. All such route proposals would then be offered for competitive bidding through a reverse bidding mechanism and the route would be awarded to the participant quoting the lowest VGF per seat. The operator submitting the original proposal would have the "Right of First Refusal" on matching the lowest bid in case his original bid is within 10% of the lowest bid. The successful bidder would then have exclusive rights to operate the route for a period of three years. Such support would be withdrawn after a three year period, as by that time, the route is expected to become self-sustainable."

The Ministry of Civil Aviation's note continues in that "the selected airline operator would have to provide a minimum of 9 and a maximum of 40 UDAN seats (subsidised rates) on UDAN flights for operations through fixed wing aircraft and a minimum of 5 and a maximum of 13 seats on the Flights for operations through helicopters. On each such route, the minimum frequency would be three and maximum of seven departures per week. Route networks would also be encouraged under the scheme to achieve economies of scale and optimal usage of aircraft".

Herein lies the rub : "Fare for a one hour journey of some 500 km on a fixed wing aircraft or for a 30 minute journey on a helicopter would be capped at Rs 2,500, with proportionate pricing for routes of different stage lengths/flight duration. This would be achieved through (i) a financial stimulus in the form of concessions from Central and State governments and airport

SpiceJet Bombardier Dash 8 Q400

Jet Airways ATR 72

operators and (ii) a *Viability Gap Funding* to the interested airlines to kick-off operations from such airports so that the passenger fares are kept affordable".

Clarifying on this scheme, "the Central Government would provide concessions in the form of reduced excise duty, service tax, permission to trade ASKMs for non-RCS (UDAN) seats and flexibility of code sharing at the RCS (UDAN) airports. However, state governments will have to lower the VAT on ATF to 1% or less, besides providing security and fire services free of cost and electricity, water and other utilities at substantially concessional rates. Airport operators would not impose Landing and Parking charges and Terminal Navigation Landing charges in addition to discounts on Route Navigation Facility charges."

Such a *Regional Connectivity Fund* (hark to the United States *Essential Air Services Act)* would be created to meet the viability gap funding requirements under the scheme, the RCF levy per departure applied to certain domestic flights. The partner State Governments (other than North Eastern States and Union Territories where contribution will be 10 %) would contribute a 20% share to this fund. For balanced regional growth, the allocations under the scheme would be equitably spread across the five geographical regions of the country viz. North, West, South, East and North-East.

"States have a key role under the scheme. The selection of airports where UDAN operations would start would be done in consultation with State Government and after confirmation of their concessions, recalling that revival of dysfunctional airports and starting operations on un-served airports has been a long standing demand of most States and this will be addressed through UDAN to a large extent".

The Ministry concludes its missive in that "UDAN is likely to a give a major fillip to tourism and employment generation in the hinterland … through introduction of helicopters and small aircraft, it is also likely to significantly reduce travel timings in remote and hilly regions, as well as islands and other areas of the country."

First off the block

While the views and responses of various privately-owned airlines of India have not been formally voiced, state-owned Air India has quickly got off the starting block: Chairman Ashwani Lohani recently met the representatives of 15 States to determine potential routes. "The representatives gave us many suggestions and we will finalise a plan in 10 days", Lohani later stated, and that the airline was trying to increase its domestic connectivity, especially in smaller towns, using regional airliners such as the ATR-72 and ATR-42. "With our new fleet acquisition plan, we plan to connect unconnected cities. This also makes perfect business sense."

The airline has asked for viability gap funding (VGF) from various state governments to ensure it does not have to face losses in case the routes turn out to be unviable. "Some routes like Mumbai-Nagpur will be profitable. So we don't need any support. For the others, we have asked for viability funding. Many state governments like Chhattisgarh, Maharashtra and Gujarat have shown interest," Lohani said. "VGF can come in the form of a state government underwriting losses that the airline makes on the routes."

In keeping with the plan of connecting under-served routes, Air India is adding almost 50 routes, most of these are new. Some of the proposed direct connectivity routes are Delhi-Porbander, Mysuru-Goa, Delhi-Pantnagar, Lucknow-Dehra Dun as also connectivity to the Andaman & Nicobar Islands and Lakshadweep.

HAL offers its 228s for the civil market

At long last, the powers have 'discovered' that India has been building regional airliners or commuter aircraft for over 30 years! HAL's Transport Aircraft Division at Kanpur has manufactured the 19-seat Dornier 228 since 1985 with over 130 delivered, mostly to the Indian Air Force, Navy and Coast Guard but over a dozen also built for civil operators including the erstwhile Vayudoot as also Jagson Airlines, UB Airways and the DGCA.

In early 2016, with the Regional Air Connectivity Scheme getting underway, HAL took the initiative to build additional Dornier 228s, specifically for the civil market and this was first made public during DefExpo 2016 at Goa in March 2016. On 10 December 2016, the Minister of State for Civil Aviation Jayant Sinha 'inaugurated' structural assembly of HAL's first such civil variant Dornier 228 at HAL's Kanpur facility. "We are keen to take forward our Regional Connectivity Scheme (RCS) and HAL has an important role to play in this," he said. The Minister pointed out that there is a market demand for at least 200 such aircraft and the government would conclude the contract with HAL once the first aircraft is rolledout (*see picture).*

Speaking on the occasion, T Suvarna Raju, CMD, HAL said he expected the first aircraft to rollout by April 2017. The Dornier 228-201 'upgraded version' is the most obvious aircraft for Indian operators for Regional Connectivity Scheme (RCS). "Our aim is to help the Government in its mission to provide affordable and sustainable air travel with access to various parts of India. As a proactive step in this direction the HAL Board sanctioned Rs 100 crore for two civil variants though there is no firm order. We see a big business opportunity in this segment for next 10 years," he said. HAL has already begun manufacturing these two civil demonstrator aircraft.

The Kanpur Division has been given civil certification CAR 21 for manufacture and CAR 145 for Maintenance Repair & Overhaul (MRO) of Dornier 228-201 aircraft.

The HAL-Dornier 228

One of the first German-built Dornier 228 light transport aircraft of Vayudoot Airlines

India's own light transport aircraft

The Dornier 228 represented the new generation of commuter and utility aircraft, incorporating advanced technology in design, manufacture and potential for future growth. Conforming to FAR 23 Part 135 Appendix 'A' regulations for commuter operations, the 19-seater Dornier 228-200 series had the twin, and normally not available together, advantages of STOL performance in hot-and-high conditions as well as high cruise speed and long range, all at unusually low operating costs. This would make the aircraft extremely versatile and cost-effective for Vayudoot which could operate the aircraft with flexibility and reliability from a variety of airfields including semi-prepared airstrips in difficult terrain. With its operating costs some one-third of those of competitive aircraft, Vayudoot could plan economic returns on new and unknown sectors.

For the defence services, the Dornier 228 provided equal versatility combining excellent field performance with good payload-range and long endurance, apart from the savings in fuel and maintenance costs owing to its rugged design features.

For Hindustan Aeronautics Limited, the Dornier 228 represented the opportunity to finally participate in the LTA programme it had set out for five years earlier. In the comprehensive transfer-of-technology contract, Dornier would assist HAL in establishing production facilities for the aircraft, its powerplants, avionics and accessories, jointly develop special variants of the aircraft to meet the multifarious—and not always compatible—requirements of various operators and, in a phased manner, evolve growth versions of the aircraft to meet future requirements.

HAL's Kanpur Division was selected to manufacture the airframe, including the wing of new technology, and composite materials for its structure while the Garrett TPE 331 turboprop engines would be built at the Bangalore Division and accessories/avionics at HAL Lucknow/Hyderabad Divisions. Indian operators would take advantage of various developmental benefits that an aircraft of the Dornier 228 at the beginning of its career offered.

That the HAL-built Dornier 228 was intended not only to be a fully-indigenous aircraft but on which future transport Aircraft designs are based, was revealed from the Government's comprehensive planning where even raw material for the airframe, accessories and engines would be locally sourced. That, plus the programme for export of HAL-built 228s to a large exclusive marketing territory, was a major step towards fulfilment of the national policy for self-reliance in the aeronautical field.

Vayudoot is born and airborne

Meanwhile, Vayudoot was airborne, having inaugurated its air services with some fanfare on 26 January 1981 with a leased Fokker F-27 of Indian Airlines on the short hop from Gauhati to Barapani (in the foothills of Shillong).

Vayudoot, as a registered company had been founded as the third-level feeder airline in the country only a few days earlier, on 20th January. The objective was "to provide communication to remote areas,

HAL Avro/HS-748 of Vayudoot at Palam Airport, Delhi

distant states and places, particularly the North-Eastern region of the country." The decision to form the company was taken in a high-level ministerial meeting on 7 January 1981 although the feeder airline was almost called *Ashok Airlines,* the title *Vayudoot* subsequently adopted. The following resolution was framed : "The authorised capital of the company being set up for operating third-level air services will be Rs. 25 crore… the paid up capital during the sixth plan period will be Rs. 6.5 crore.... of which Rs. 1 crore will be paid up before 31 March 1981, Rs. 50 lakh by Air India and Rs. 50 lakh by Indian Airlines."

Funds provided by the two national air carriers for the purpose of investments as equity capital of the new company were released by the government as budgetary support.

Vayudoot was thus formed with equal equity participation by Indian Airlines and Air India, the capital being raised to Rs 2 crore by March 1982, and additional funds subscribed by the two airlines towards raising the equity capital of Vayudoot. An organisational structure was finalised, with nine members on the board, including the chairman. Of these Indian Airlines and Air India nominated two representatives

Dornier 228s of Bhutan's nascent airline Druk Air were 'wet leased' by Vayudoot before their own aircraft were received

each, two were from the Ministry of Civil Aviation, one from the Department of Tourism, plus the general manager himself.

Vayudoot's Head Office was located in a wing of Indian Airline's cabin crew training centre at New Delhi's Safdarjung Airport. A number of staff were recruited, although most operational personnel were ex-Indian Airlines. Vayudoot heavily depended on Indian Airlines support for some years, from leased aircraft and aircrew (in the initial Stages) to maintenance, logistics and commercial support.

Vayudoot commenced its operations in the North-Eastern area by connecting seven stations with Gauhati, chosen as the base station for this region. The Fokker F.27s were on wet-lease from Indian Airlines and were initially operated, in addition to the Gauhati-Barapani route, from Gauhati to Kailashar-Agartala, to Rupsi, to Kamalpur-Agartala and from Dibrugarh (or Chabua) to Tezu.

After just over a year, in April 1982, Vayudoot readjusted these services by discontinuing the flights to Rupsi and Kamalpur, but extending the Gauhati-Barapani services to Silchar and back.

An important event was Vayudoot's launch of air services in Northern India, connecting Delhi with Ludhiana in the Punjab from March 1982 with a wet-leased HAL /BAe 748. Soon after, Vayudoot initiated air services from Delhi to Dehra Dun and later, to Chandigarh-Kulu, these services being extremely popular, heavily booked and bringing much-needed revenue to Vayudoot. Later, Hissar was added.

In the east, Vayudoot launched F.27 services from Calcutta to Jamshedpur-Rourkela-Ranchi to service the steel-coal belt, while also extending a service to Patna-Muzaffarpur. The latter, however, was not practical and resulted in heavy losses, being soon suspended in June 1982.

The financial position certainly remained bleak. In the first year of operations, Vayudoot incurred a loss of Rs 66 lakh despite the limited scale of operations. This was explained away as resulting from "low fares, low seating factors and uneconomical aircraft." On the credit side was Vayudoot's national role in expanding air transportation "to meet socio-economic objectives." Continuing losses in 1982-83 were accepted as inevitable, although they mounted to Rs. 109 lakh. Thus, in the first two years, Vayudoot's accumulated losses of Rs 176 lakh almost wiped out the equity capital initially provided.

Clearly, the lack of a suitable, cost-effective aircraft for air operation was becoming a heavy cross to bear and Vayudoot could only tighten its belt, abandon certain non-remunerative routes, increase operations on high-yield routes, apply for exemption on aviation fuel and landing charges in some states and carry out more imaginative marketing. The results were heartening : in 1983-84, Vayudoot wiped out losses and actually chalked up a marginal profit of Rs 3.72 lakh, not only having increased its load factor and operating revenue but with exercising strict control over expenditure.

New stations were added, with Bombay becoming the fourth base, with daily flights (HAL / BAe 748) to Kandla while Pantnagar was connected from Delhi and Cooch Behar from Calcutta.

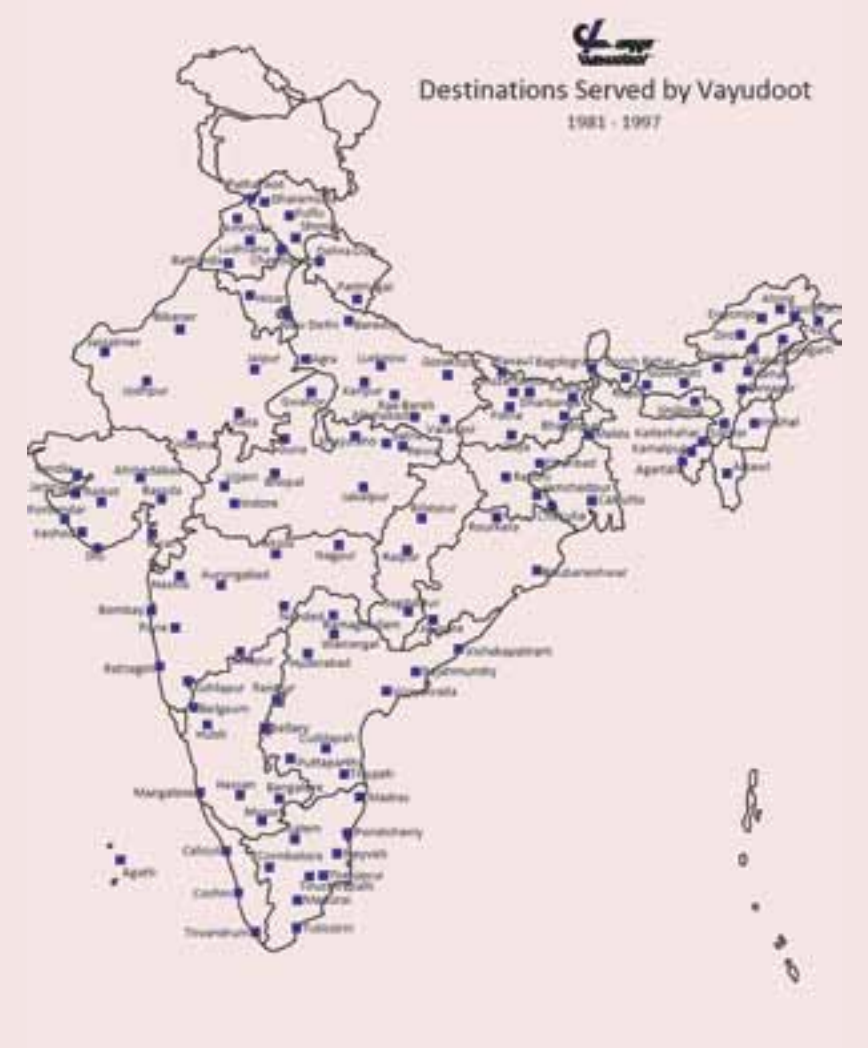
In late 1983, Vayudoot signed a wet-lease contract with Druk Air of Bhutan under which the latter started operations with its Dornier 228 light transport aircraft from Calcutta to Aizawl in Mizoram. This was a doubly significant event as, for the first time, a true commuter aircraft was flying on Vayudoot routes and Aizawl—long-considered unsuitable for operations by conventional fixed-wing aircraft because of its poor-surfaced and short airstrip—was airlinked by the Dornier 228 which had STOL performance capability. Druk Air's aircraft later extended Vayudoot's services from Calcutta to Rourkela, Ranchi and Bhubaneshwar. Thus during 1983-84, capacity was increased by 23% in terms of ATKm and RTKm went up by a vigorous 71% .

A place in the Sun

The long-awaited and much-desired induction of a 'tailor-made' commuter airliner for Vayudoot took place at a formal ceremony at Dornier's Oberpfaffenhofen airfield near Munich in West Germany on 15 November 1984. The Government of India had contracted for a number of 'fly-away' aircraft to meet the urgent requirements of various operators in India—the foremost being Vayudoot—preceding the actual licence-manufacture programme at HAL. Mahesh C Sarin, then Secretary for Defence Production, was formally handed over the first two Dornier 228-201 aircraft by Dornier which, in turn, were formally handed over by him to Captain AM Kapur, Joint Chairman of Vayudoot, Indian Airlines and Air India.

Conversion training of selected Vayudoot aircrew began the same day, and the first two Dornier 228s of Vayudoot were ferried from their Munich point of departure in West Germany, arriving at Delhi on 18 December 1984, staging through Crete, Egypt, Bahrain and Karachi. Commanded by Capts. Madhu Dayal, HS Soorma and Ramesh Chander

First Dornier 228 of Vayudoot on arrival at Palam airport, Delhi in December 1984



At its peak, Vayudoot had just under 90 stations on its map – only that most of them were not served after some initial fanfare

of Vayudoot and Capt. Frank Tutygens of Dornier, the aircraft demonstrated the remarkably long range that is characteristic of this new generation of light transport as they needed only four refuelling stops enroute over some 7,000 km.

Route-proving flights and training of additional aircrew took a few weeks before Vayudoot's first official scheduled flight with their new Dornier 228 was launched, on 2 January 1985 from Delhi to Rae Barelli and on to Lucknow-Dehra Dun and return although it was intended to operate the Dornier 228s from the centre of city Safdarjung airport, procedural aspects dictated that Palam international airport be used.

The second Dornier 228 was positioned at Santa Cruz airport, Bombay and began scheduled air services to Surat-Bhavnagar-Ahmedabad in Gujarat on 4 February 1985, Vayudoot recording nearly cent per cent seat factors almost immediately. Vayudoot's Dornier 228 was also operated on the Bombay-Aurangabad-Nanded sector in the mornings and along the coastline from Bombay to Ratnagiri in the afternoons.

With a third Dornier 228-201 arriving on 24 February 1985, Vayudoot were in a position to start operations for the first time in Southern India. With Hyderabad as their new base, Vayudoot's Dornier 228 services began on 6 April, inaugurating air links to Rajahmundry and Cuddapah. From 8 April, Hyderabad was connected with Tirupati and thence to Mysore-Bangalore. With the addition of these six points, Vayudoot were operating to 31 stations in the country by mid-1985.

An additional two Dornier 228s were received from Germany in November 1985, enabling Vayudoot to expand its eastern and north-eastern services, besides increasing frequency in other regions. Based at Dum Dum airport, Vayudoot's Dornier 228 launched services to Rourkela, Ranchi and Bhubaneshwar in the coal belt area and to Arunachal Pradesh later in the year. In December 1985, a thrice-weekly service to link Calcutta with Aizawal, the capital of Mizoram, was introduced, this being the 46th station on the network. During the six months till September 1985, Vayudoot had transported 102,963 passengers and was set about launching package tours for tourists, an imaginative scheme that brought domestic tourism to the fore in the Himachal and Rajasthan areas.

An interesting marketing innovation, that would also increase fleet utilisation, Vayudoot's 'Holiday Package Tours', offered group package tours to popular holiday resorts in Northern India. Aimed at the middle and lower income groups of tourists who would otherwise not fly, the "flying packages" were offered in collaboration with State Government Tourism Departments, including UP, to Haridwar-Rishikesh-Mussoorie, in and around the Doon valley and HP, to Kulu and Manali in the Himalayas. Vayudoot had other marketing strategies which included special charters and high-value cargo flights.

At the end of March 1986, Vayudoot had 57 stations on line, had flown 232,837 passengers, reflecting a growth of 54% with an average load factor of 62%. Further expansion had to await additional aircraft and these were to be in the form of the first in-country built Dornier 228s. The capacity of Vayudoot was thus doubled when, in March 1986, the first five HAL-built Dornier 228s were handed over to the airline at an official ceremony at Kanpur.

Déjà vu:

The *Night Airmail Service* (NAMS) between Delhi and Bombay, via Jaipur and Nagpur, was inaugurated on 2 June 1986, the service being extended to Calcutta, Varanasi, Bangalore, Hyderabad and Madras. Operated with four Dornier 228s, the service radiated from the four metropolitan cities of New Delhi, Bombay, Calcutta and Madras all linking at Nagpur, the geographic centre of the sub continent, where the mail was exchanged for onward transmission.

Vayudoot also introduced the 'Rent-a-Plane' scheme, devised to meet specific business and tourist traffic requirements,

Vayudoot becomes IA (SHOD)

Dornier 228 repainted in colours of Indian Airlines

It was tragic that no one, neither the Government nor the travelling public, really lamented the passing away of India's first genuine feeder/commuter/third-level airline which was conceived in the mid-seventies, born in the early eighties and destroyed by the System (and an ambitions management) in the early nineties. Vayudoot ceased to exist as a separate entity. Operations had been launched in India's north-east, as planned, with Guwahati as its maintenance base, first connecting Shillong (Barapani) but eventually Vayudoot's network increased with services to about 105 (in 1989-90) stations all over India, with bases at Delhi, Bombay, Calcutta, Hyderabad and Madras. Vayudoot even linked the Lakshadweep Islands (Agatti) to South-Western India. But, everyone–the Government particularly–forgot that it was the North-East which actually was the *raison d'être* for Vayudoot's existence! The political and economic price that India had to pay for this aberration cannot be quantified.

From the early 1990s, Vayudoot remained under suspended animation, a result of the earlier, unprofessional leadership, lack of a maintenance system for its fleet, gross political interference, and abject bureaucratic bungling. In 1993, the Government took the decision to merge Vayudoot with Indian Airlines (IA taking over the 50% of equity holding from Air India) and absorbing Vayudoot's personnel into Indian Airlines, Air India, the Hotel Corporation of India, ITDC Hotels and AAI.

In 1993, after just over a decade of existence, the Government's experiment with commuter or third-level air services had been terminated. Vayudoot, once named the world's 'biggest little airline', turned out to be the biggest loser! Following management measures taken to improve upon its working, losses were brought down in 1991-92 to Rs 30.59 crore from Rs 37 crore the previous year. Rationalisation of operations continued during 1992-93 and the losses during the period April-December 1992 were estimated at Rs 16 crore against Rs 25 crore in the corresponding period of 1991-92. The accumulated losses of Vayudoot as on 31 March 1992 were Rs 158.19 crore.

The remaining personnel and aircraft of the erstwhile Vayudoot then became part of the 'Short Haul Operations Division' (SHOD) of Indian Airlines. At the time of its merger, Vayudoot had a fleet of eight Dornier 228s and eight Avro/HS 748 aircraft but only three and one respectively were airworthy. The curtains were finally drawn on this drama well before end of the 20th century.

yet another innovative dimension to its diversification plans. This was followed in early 1987 by the 'Himalayan Air Trek', aimed primarly at the foreign tourist or businessman, being a Sunday morning excursion from Delhi, via Dehra Dun, following the Ganges river almost to its source in the Garhwal Himalaya.

The number of new points continued to increase and by March 1987, there were 84 on-line stations. During the financial year 1986-87, Vayudoot flew some 450,000 passengers, recording a 94% growth rate, with a load factor (of 67%. But the strain had to tell as the supporting infrastructure on ground was clearly unable to keep pace with Vayudoot's ambitious flying. A review of the scale of operations and commensurate maintenance support needs made it imperative that Vayudoot bring up its base level before embarking on further expansion. Its aircraft, personnel and resources were obviously strained. Each Dornier 228, for instance, was recording an average of 2500-2800 flying tours per year and the elderly Fokker F.27s and HAL-BAe 748s required urgent overhaul. For the major 300, 600 and 1800 hour overhauls, the 748s were sent to Hyderabad, the F.27s to Calcutta, to the Do-228s to Delhi.

In its eighth year, Vayudoot clearly needed time to consolidate. Thus between April and September 1987, Vayudoot added just another 3 stations, taking the total to 87. However, another 41 stations were earmarked for air linking during the remaining 5-year plan period when Vayudoot would pass, and go well beyond, the century mark.

Something had to give, and it did *(see box)*.

Missed Opportunities

Developing indigenous regional airliners

It was a *déjà* vu kind of situation when, ten years after the policy statement was first made, the Government of India once again urged the national aviation industry to work on developing civil airliners. In 1996, HD Deve Gowda, then Prime Minister, had directed HAL to do so, specifying two categories, 50 – and 100-seaters. Neither programmes proceeded and inspite of an agreement with ATR, not a single step was taken to licence build this aircraft in India. Instead, well over one hundred ATR-42s and 72s were imported by the national airlines which today are flying in various colours ! As for the 100-seater, this made no headway at all and the fantastic opportunity in 2003 for acquiring the futuristic Fairchild-Dornier 728 and 928 programmes at virtually give away prices, was spurned (*see related item*). Now Indian industry wants to re-invent the wheel.

As then reported, "the entire brains trust of Indian aviation – scientists, developers and operators – met at the office of the Minister for Defence on 23 September 2008 to initiate an ambitious project to manufacture civil regional aircraft. The mission would be to develop a cheap, rugged and easy to maintain 70 to 110-seater civilian aircraft that should start rolling out within a decade." However, there was no clarification on aspects such as work share, funding and whether the aircraft would be turboprop or turbofan powered. It was too early for these details. Instead, "The team entrusted with such task will soon come back with a detailed project report."

The period from development to certification was estimated (ambitiously) to take some six years. "In case the project is successful, India will join a select group of companies manufacturing 70 to 100-seat jets. Companies currently producing regional airlines of the same category are Embraer, Bombardier, Mitsubishi, Sukhoi and AVIC of China."

The 'roll call' of those personalities present at the meeting indicated the Government's seriousness in pursuing the proposal whose development cost had been pegged at Rs 4,000 crore. Those at the session included Principal Secretary to the Prime Minister, Defence Secretary, Civil Aviation Secretary, CSIR Director General, Space Commission Chairman, Director National Aerospace Laboratories, Director Aeronautical Development Agency, Chairman HAL and representatives from the DRDO – as also Air India. The meeting concluded with the statement that "India has the technical base as also the resources to develop an aircraft of this size for both domestic and international markets." To be called the *Indian Regional Transport Aircraft,* this programme was to reduce import dependence to a considerable degree. "It is estimated that India will require over 1,200 such 70-100-seater aircraft by 2026."

So what happened?

"The 728/928 could well have been India's own regional jetliners"

The *National Aeronautics Policy Document,* articulated in 1994, made clear references on the need for the Indian industry to be involved in development and production of passenger jet airliners and to establish world class facilities for such aircraft production and maintenance in the country. Later, President Dr APJ Abdul Kalam re-emphasised this imperative while calling for steps to design and develop passenger jet aircraft in the country. "At this juncture, we need to introspect on how long can we be indifferent to the national need and abstain from selecting an international consortium for new generation jet airliners".

The immense potential for regional and low cost airlines in the world, including India, had prompted some global aviation majors to knock at India's doors exhorting Indian participation in their regional aircraft programmes. Brazil's Embraer with their ERJ 175 /195 Canadian Bombardier with the CRJ 700/900 and Germany's Fairchild Dornier Aero Industries with the 728/928 had been front-runners in this new generation airliner range, the latter being considered as the most optimum and advanced. However the company went insolvent in 2002 leaving midway the development of this futuristic jetliner.

While China had earlier (unsuccessfully) flirted with this project, the 728 programme was at India's doorstep, and could well have imparted an unprecedented opportunity to the Indian aerospace industry to launch itself directly into a regional jet programme, benefiting from the technology and infrastructure already advanced in Germany. Certainly, this could have been a strategic opening for India to literally propel itself to the highest level of civil aviation technology, thereafter becoming a lead player in global markets.

Taking over the entire 728/928 programme would reportedly have been at a fraction of the actual value of the aircraft programme. Should HAL, or for that matter any other Indian corporate, have taken over these assets, the Indian aircraft industry consortium could have saved more than three years in time and thousands of crores for intellectual and design rights and gained a major share in further design and development. It would not just have fulfilled the dream for an indigenous regional airliner for the country, but also established the foundations for a massive export market and future production base for world-class airliners. The acquisition of such new-generation regional airliners could well have become the first transnational holding for HAL, opening the path for truly international vistas, and a new global identity for the Indian aviation industry. This opportunity beckoned a revolution in Indian aviation industry.

Alas, the opportunity was missed, neither the Government or Industry seriously examining the windfall!

Indian Aviation in 2017-18

Surging traffic–but constraints to be critical

This report from CAPA reviews India's status as the fastest growing aviation market in the world which creates tremendous opportunities, but risks are also heightened as the inadequacy of India's infrastructure planning, a fast emerging shortage of skills, flawed policy initiatives, and weak regulatory oversight threaten to become major stumbling blocks. The potential is enormous, but unless the government takes suitable measures, this will be seriously constrained.

The year 2016 represented a turnaround in the fortunes of India's aviation industry after several difficult years. Lower fuel prices combined with modest capacity growth and strengthening of economic fundamentals were largely responsible for surging traffic and an improvement in airline financials during FY2016. Domestic traffic was up 21.2% while international traffic grew by a more modest 7.7%.

India's airlines reported a combined profit of $122 million in FY2016, returning to profitability for the first time in a decade. This included record profits at IndiGo, Jet Airways, SpiceJet, GoAir and Air India Express.

However, AirAsia India and Vistara, still in their initial years of operations, were loss making, as did the national carrier, Air India, although the latter reported its first (modest) operating profit in a decade.

Domestic market on track to cross 100 million passengers

After a strong FY2016, traffic growth has accelerated further in FY2017, with India likely to overtake Japan to become the world's third largest domestic market after the USA and China. In reaching this milestone, India will have achieved

IndiGo could control over half of the domestic market in the next two years (photo: Angad Singh)

Air India still operates a small number of Boeing 747-400s, mainly on regional international routes (photo: Adrian Pingstone)

average domestic traffic growth of over 15% per annum since liberalisation of the sector commenced in FY2004.

Strong economic fundamentals have contributed to the growth, although traffic has been "over-stimulated" by low fares. India was expected to achieve 7.5% GDP growth in FY2017, with the IMF projecting that economic performance should improve still further over the next five years.

However, ramifications of the Indian government's demonetisation initiative announced in November 2016 (which resulted in the withdrawal and replacement of around 86% of the value of currency in circulation, to reduce the volume of undeclared cash in the economy) are still unclear, although there is no visible impact as yet. Traffic growth remained strong in December 2016 and there are no signs yet of a slowdown. Purchase of air tickets using withdrawn denominations was permitted until the first half of December 2016, which may result in a delayed impact in the first half of FY2018. As of now, it is difficult to fully factor in what the impact may be, if any.

The next financial year is expected to be the third consecutive year of domestic growth above 20%. Domestic traffic in FY2018 could approach 130 million passengers, growing as much as by 25%, but may be tempered by 3-5 percentage points because of the impact of demonetisation. The introduction of the GST in mid-2017 may possibly also have a short-term negative impact on economic growth until more positive results emerge.

Capacity addition, expanding economy and LCCs

Based on aircraft deliveries, competitive dynamics and the positive outlook for the economy, domestic growth at 20% or higher could continue for up to a further two years.

India's airlines are scheduled to induct 60-65 narrow bodies and 10-12 regional aircraft shortly and the pace of aircraft inductions will be one of the key drivers of traffic growth. This is, however, subject to deliveries of A320neos proceeding as scheduled, and operators being able to deploy the equipment as planned, as some operational challenges have been experienced.

With Low-Cost Carriers (LCCs) taking delivery of the clear majority of narrow body aircraft coming into the market (an estimated 50 out of 65 inductions), their share of the domestic market is expected to rise from around 65% today to reach 75-80% within two years. The last time that LCCs had a similar market position was in early 2011 when their share stood at over 70%. However, on that occasion it was as a result of a blurred demarcation between the full service and low cost operations of Jet Airways and Kingfisher. Airline business models in the market are better defined today and LCCs will have a clearly dominant position.

IndiGo, in particular, with its incredible domestic capacity growth, is playing a key role in moving the market. The airline's share of domestic traffic has crossed 40% and could approach 55-60% within the next two years, a remarkable achievement in such a large and competitive market. As its share grows the carrier is becoming more competitive with its pricing.

IndiGo will take delivery of more than two aircraft a month through to March 2018, which will see its fleet size reach 160 by then (of which around 140-145 aircraft will operate on domestic routes). The improved economics of the A320neo will further strengthen IndiGo's market position. The carrier is already highly profitable and the market leader on all counts.

On the other hand, while LCCs will grow more aggressively on international routes from Summer 2017 onward, overseas routes will remain modest in terms of total operations. IndiGo and SpiceJet have pursued relatively modest expansion on international routes to date, preferring instead to focus on the domestic market. However, both carriers are expected to ramp up their international services from Summer 2017. This is also when GoAir plans to commence international services for the first time, primarily to unconnected destinations in Central Asia, the Gulf, China and Vietnam.

Re-engined narrowbodies have the potential to transform the economics of regional international routes by making more city pairs viable. However, despite the overseas opportunities, the domestic market will remain the core focus for LCCs. At IndiGo for example, international operations are expected to account for only 10-15% of total capacity.

The LCC boom could see full service airline market share fall commensurately to 20-25% within two years, and Jet Airways and Air India could each see their share fall to around 10% or less unless they pursue faster expansion. In any case, the full service airline model continues to decline in relative terms. Jet Airways and Air India, which together had a combined domestic market share of close to 90% in 2003 could each see their hold on the market fall to around 10% each or less within two years unless they accelerate their expansion. This pace of IndiGo's growth is creating a strategic compulsion for other Indian carriers to scale up to remain relevant.

International traffic up–but constrained by bilaterals

Overall international traffic is expected to expand at 10-12% in FY2017 and FY2018, but bilateral restrictions preclude achieving true potential. Most of the ten largest international carriers are achieving year-round average load factors of 90% or higher, indicating constrained capacity. But for India's unhelpful restrictions, international growth could be in the region of 15-17% per annum, which would result in international traffic volumes doubling within five years. However, demonetisation could negatively impact demand for short haul tourist destinations such as Dubai, Singapore and Thailand.

Several Gulf and Asian carriers are seeking additional entitlements to the tune of up to 150,000 weekly seats. Bilaterals have become a key issue in India's geopolitical relations with markets such as the UAE, Qatar, Turkey, Hong Kong, Singapore and Malaysia. The Indian government may only agree to more modest incremental expansion in seats than is being sought by some countries.

Among Indian carriers, Air India continues to expand its international footprint, primarily using Boeing 787s, increasing its European and North American network, launching new non-stop services from Delhi to Vienna, San Francisco and Madrid over the last 12 months and a one-stop between Ahmedabad and Newark via London. New destinations under consideration for next year include Washington, Toronto, Nairobi, Tel Aviv, Copenhagen and Stockholm. But CAPA believes that the viability of Air India's ultra-long haul routes could increasingly be challenged beginning FY2018 owing to cost creep and a possible softening of yields.

A new direction for the future of Air India could be a surprise development, possibly before 2019, as there is no prospect of sustainable profitability under government ownership. After its first operating profit in 10 years in FY2016, Air India is again headed for an operating loss in FY2018. The current administration is showing signs of reluctance to continually fund losses and CAPA does not rule out a significant decision on the future of the national carrier. There may finally be political appetite for a meaningful restructuring, including privatisation, before 2019.

Meanwhile, Jet Airways is likely to revive its long haul ambitions and may possibly join SkyTeam in 2017 or 2018. The airline is focusing on international growth and the Amsterdam hub signals a revival of its long haul ambitions. The re-induction of 10 Boeing 777s that Jet had sub-leased to other airlines could be used to launch several new routes. The carrier has also been up-gauging capacity to Amsterdam and Paris and has entered into extensive codeshare agreements with Delta, Air France and KLM for connectivity to the US and Canada. Closer cooperation with these airlines may be a prelude to SkyTeam membership in the next two years.

Massive aircraft orders in the offing

India's airlines could place orders for 250-300 aircraft (including options) in the next 6-odd months (see *India News* in this issue). SpiceJet first, followed by Vistara, will be the primary drivers of new aircraft orders, both of whom are expected to stick with Boeing and Airbus respectively for their narrowbody fleet requirements. For long haul operations, Vistara is likely to opt for the 777X.

The government's decision to remove the five-year qualification requirement for domestic airlines to be permitted to operate international services and to retain only the 20-aircraft threshold, may push Vistara and AirAsia India to expand on domestic routes faster than planned. Vistara could bring forward deliveries to reach 20 aircraft by March 2018. AirAsia India is also likely to pursue a more aggressive growth path to remain competitive in the market. However, both carriers will need significantly higher levels of capital to pursue their accelerated expansion strategies.

Even lessor interest in the Indian market is returning as memories of the aircraft recovery challenges experienced following the collapse of Kingfisher, start to fade. The strong turnaround by SpiceJet in the last two years has also helped to restore confidence in the market. However, recent regulatory hurdles which have stalled

SpiceJet is adding a massive number of Boeing 737s to its fleet in the coming years (photo: Angad Singh)

AirAsia will need capital to expand its India footprint in order to take advantage of the revised 0/20 norms (photo: Airbus/P Pigeyre)

the implementation of the Cape Town Convention in the Indian civil aviation code, despite India being a signatory to the agreement, could impact the country's risk rating.

In order to finance this buying, Indian carriers are expected to seek to raise around $1 billion of capital next year, led by Jet Airways at $300-400 million. Jet's improvement in performance on domestic routes in FY2016 appears to have peaked, and investment in product enhancement is a critical issue for the carrier to remain competitive.

AirAsia India and Vistara are also likely to require significant recapitalisation in FY2018 to provide for much larger war chests in the face of strong competition. Following its recent funding exercise in November 2016, AirAsia India may need another tranche of capital by Q3 2018 and Vistara may need significant funding once it has taken a decision on acceleration of its fleet expansion. But apart from the recent equity infusion in AirAsia India there has been limited progress on the capital raising front, with most plans delayed. The window for carriers seeking capital through IPOs or external funding may narrow as market dynamics are expected to deteriorate over the next 18 months with rapid capacity expansion placing downward pressure on yields, and cost creep visible.

Another investment by a foreign airline in an Indian carrier (which does not currently have an overseas investor) is possible. The delay in expanding bilateral air services agreements may precipitate such an investment to achieve market access, although the deal may not quite be in the mould of the Jet-Etihad strategic partnership.

However, the Indian government's recent bold decision to permit 100% Foreign Direct Investment (FDI) in domestic carriers is unlikely to result in any transactions to that level in FY2018.

Rapid growth is straining infrastructure, increasing safety and security risks

Skills shortages are emerging with airlines facing particular challenges in recruiting sufficient commanders. This is already impacting on expansion plans. Meanwhile the institutional and regulatory framework at the Directorate General of Civil Aviation (DGCA) and the Bureau of Civil Aviation Security (BCAS) is particularly weak and under-resourced. And these issues do not appear to be receiving the urgent attention that they require.

In addition, capacity constraints at a number of India's metro airports have already become visible. The situation at key metros such as Mumbai and Chennai is particularly acute as these airports are fast approaching saturation. But slot constraints and congestion are an issue at most of the metro airports and are expected to remain so for the near term as new terminals and runways will take 2-3 years to develop.


Jet Airways' domestic operations centre around its Boeing 737 fleet (photo: Angad Singh)

Regional aviation in India is in need of review (photo: Angad Singh)

Delays in developing a long-term national airport plan could well jeopardise economic growth. Based on projected growth rates, most of the 40 largest airports in the country will exceed their design capacities within the next decade. However, there is serious concern that there is no long-term vision for India's airport capacity requirements. There will be vast economic ramifications if air connectivity to India's centres of commerce, industry and tourism is choked due to airports being saturated.

Development of airports of national importance have been subject to lengthy delays, and there is a need to accelerate the award of greenfield airport concessions, many of which – such as Navi Mumbai – have been subject to inordinate delays. In fact, the Navi Mumbai tender could potentially be subject to more delays, which would mean commissioning of the new airport could take a further 5-7 years.

The award of the concession for Goa Mopa in August 2016 broke a recent drought in privatisation of airports, and Nagpur Mihan and Bhogapuram could be the next to be decided, with more opportunities expected from next year. However, precious capital for airport development needs to be well-directed towards viable projects. India's most recently constructed greenfield airport at Durgapur in West Bengal, built with 100% private capital, has struggled to attract commercial airline operators. Air India briefly served the airport but has since suspended services owing to insufficient demand. Reliance's investment in regional airports in Maharashtra, and IL&FS's interest in projects in Karnataka have similarly failed to perform.

The tender process which awards concession to the bidder offering the highest revenue share needs to be reviewed. The current evaluation criteria of bids which favours aggressive revenue shares is not helpful to airport development, as it ultimately results in higher charges for airlines and consumers, deters investors and serves only to subsidise losses at AAI airports.

Airspace is another potential choke-point on the supply side. If this sector is to receive the management attention and capital that it needs to keep pace with projected growth, the Air Navigation Services division of the Airports Authority of India needs to be hived-off as a separate entity and corporatised. After a couple of false starts, signs are emerging that this could be back on the agenda.

NCAP needs review

The New Civil Aviation Policy (NCAP) announced in June 2016 was a document almost 20 years in the making. This is the first time that India has had a single document vision for the aviation sector and that is a welcome development.

But intrinsic flaws in the policy, particularly with respect to regional connectivity, ground handling and bilateral policy, mean that it will be difficult to implement in practice and could inadvertently act as an obstacle to achieving desired objectives. The NCAP requires a thorough review to ensure that India has a policy that will deliver the aviation sector that it needs.

Because of weaknesses in the policy, little has changed on the ground since it was released. Furthermore, several issues that are fundamental to the long-term sustainability of the sector have been ignored, namely strengthening and restructuring of the DGCA and BCAS, and developing a viable business plan for Air India and the Airports Authority of India, both of which continue to operate sub-optimally.

The Ministry of Civil Aviation deserves significant recognition for actively consulting and engaging with the industry on a regular and positive basis to identify and address issues. The strategy of engagement and taking accountability is highly welcome and demonstrates a commitment to listening to problems and developing solutions.

Taxes and levies increase pressures

Other clouds on the horizon include uncertainty related to the rate that will apply on aviation following the implementation of the Goods and Services Tax (GST). Although intended to simplify India's complex tax code and generally viewed as being positive for the economy in the long term, a higher effective tax rate for economy class air travel could possibly increase fares by 9-12%.

Given the price sensitivity of Indian passengers, this could have a significant negative impact on demand. The implementation of GST may also result

As a relatively new entrant, Vistara has yet to enter profitability

in higher upfront costs for aircraft and leases, spares and parts, and distribution costs, increasing cash flow requirements, although airlines will receive input tax credits later.

Caution on industry profits

Traffic is surging but last year's profits may have been a high-water mark; the industry is expected to return to losses in FY2017 and FY2018. Traffic growth is being stimulated above its underlying demand as a result of excess capacity and competitive fares. The downward pressure on yields, combined with cost creep, is expected to push the consolidated industry result back into the red for the 12 months ending 31 March 2017.

IndiGo, Jet Airways, SpiceJet, GoAir and Air India Express are all expected to remain profitable, but at levels lower than in FY2016. Jet Airways will be the only profitable full service carrier in FY2017, while losses are projected to increase at Air India, AirAsia India and Vistara, and total industry level losses could reach $250-300 million.

With expected cost creep of 10%, a 5-7% decline in yields, oil at $55-60 per barrel and an exchange rate of $1 to Rs 73-75, industry losses could widen further to $380-450 million in FY2018, although most LCCs are expected to remain profitable. Yields could potentially decline further than assumed given the capacity induction planned.

As the aviation industry faces the prospect of transitioning to a phase of profitless growth, the risk for India's carriers is that if they continue to expand without sufficient capitalisation they could face significant challenges when the next external shock hits. When the fuel price spike and global economic slowdown hit the industry in 2008/09, what followed was a period of widespread red ink with billions of dollars of losses which led to the failure of airlines such as Kingfisher Airlines and Paramount Airways and almost brought SpiceJet to the verge of closure. Should history repeat itself, this time the industry has much further to fall.

CAPA's comprehensive 200-page India Aviation Outlook Report FY2017/18, was released in February 2017 at the CAPA India Aviation Summit.

GoAir has become the second airline in India to operate the A320neo (photo: Airbus/H Goussé)

Business Aviation in India:
Still chasing the potential!

A Dassault Falcon 7X (VT-RGX) of Religare Aviation

Business aviation (BA) activities in India continue to remain far below their potential. In sharp contrast to the growth of scheduled airlines, business aviation in India over the last 5 years recorded a meagre 2% growth. Provided certain immediate and long term measures are taken, India is looking at a relatively conservative fleet growth projections of about 7% over a long period, a median between best case of 12% and, as is case today, of 2%, according to the first industry report released by the *Business Aircraft Operators Association* (BAOA) along with its knowledge partner, Martin Consulting LLC.

"The aim of the BAOA Industry Report is to present and make aware the contribution, role and strategic fulcrum that business aviation has played in shaping the India of today. Business aviation is no longer a corporate status symbol, but an imperative business tool needed by Captains of Industry and National Leaders to operate in a highly competitive global business environment" stated Jayant Nadkarni, President, Business Aircraft Operators Association.

The report highlights examples of efficiencies provided by business aviation,

This Embraer Phenom 300 is operated by Joy Jets, a luxury air charter service owned by the Joyalukkas jewellery group (photo: Phil Camp)

and how this makes the country "more stable and secure, as employment and economic sustenance is provided to people through industries that are set up by businesses." It enhances economic development which goes on to benefit the common man and a resurgent India. "What emerges is a powerful message: that business aviation is the catalyst India needs to grow, and we are firm in our judgment that the challenges and hurdles this industry faces must not be overlooked," said Mark D Martin, Founder & CEO, Martin Consulting LLC.

India's New Civil Aviation Policy is a step forward and has touched upon every sector of aviation, but has unfortunately left out business aviation. This is owing to the incorrect perception that the sector only benefits the affluent, and thus can be ignored. It is not appreciated that both scheduled airlines as well as business aviation are integral parts of public air transportation in any context. One cannot do without the other. Business aviation's immense contribution to India's economic growth story remains grossly unappreciated. Given the right impetus, the sector actually has the potential to create a revolution in regional connectivity and generate economic benefits for the country.

The Business Aircraft Operators Association (BAOA), is the unified voice of the business aviation sector (both commercial and private) in India, and aims to create a favourable environment for the sector's growth, ensuring better coordination amongst industry stakeholders, regulatory authorities and the Government. BAOA works closely with the Ministry of Civil Aviation (MoCA), Directorate General of Civil Aviation (DGCA), Airport Authority of India (AAI) and Bureau of Civil Aviation Security (BCAS). BAOA is also a member of the International Business Aviation Council (IBAC), which is the umbrella body for all business aviation associations worldwide. IBAC has a permanent observer's status with International Civil Aviation Organisation (ICAO) and evaluates policies and regulations, specific to the needs of business aviation and determines global best practices. BAOA has been striving for business aviation to get its rightful place in Indian aviation and get recognised as a strong enabler for faster economic growth.

The Road Map Ahead: some recommendations

Abolish Import duties: The government should rationalise custom duty policy on aviation sector, by making the import duty on aircraft zero percent and thereby entirely remove the anomaly. This immediate step will help lower costs, kick-start industry growth, bring in much needed operational efficiencies, generate employment, and provide multiplier economic benefits to India.

Strengthen the aviation regulator: The government is obligated to support the DGCA through adequate funding and professional manpower to perform its duties effectively. DGCA needs to comprise people having adequate domain knowledge and experience, with stability of fixed tenures of minimum three years to make an impact. Adequate financial independence needs to be granted to hire the right human resources and train them. E-governance is the need of the hour, and this needs to be implemented as soon as possible.

Fractional Ownership and Aircraft Management: The Government needs to encourage consolidation of NSOP industry

This Bombardier Global 5000 is owned by the Bajaj Group, as seen by the logo on the tail (photo: Angad Singh)

An Embraer Legacy 600 (EMB 135) seen taking off during Aero India 2015 (photo: Angad Singh)

through 'fractional ownership' and 'aircraft management' concepts. The operator, being an aircraft management company, achieves economy of scale by using available resources optimally to manage aircraft belonging to different owners. The Government needs to proactively facilitate these concepts. DGCA, customs department, DRI should be made aware of these worldwide concepts, needed for lowering the cost of ownership. This will facilitate seamless import of aircraft under separate ownership model. Ministry of Finance should be asked to issue clear guidelines for effecting depreciation benefits for different owners.

Promote business aviation for remote area industrialisation: The Government should recognise the role of business aviation in industrialising remote areas, and support this by lowering cost of undertaking business aircraft flights to these areas with incentives as part of new RCS policy: without VGF but lower costs.

Employ BA aircraft, especially helicopters, during disasters and in the 'golden hour' for emergency medevac: Until the helicopters of the defence forces arrive, BA resources available close to the disaster site should be utilised. The immediate hiring of BA aircraft at or near the disaster site should be made a national and state policy. Constructing roof top helipads on tall buildings in cities across India, should be made a national policy to boost EMS operations. The flexibility of helicopters should be used to save lives in accidents.

Airport watch hours: MoCA, being the nodal body, should facilitate interactions with the MoD and MHA to engage with the respective airport owners, be it AAI, HAL or the military arms, to increase watch hours at important tier-2 and tier-3 city airports. For instance, extension of watch hours at Ozhar, Daman and Surat will help meet industrial needs and also partially help in decongesting Mumbai airport.

Utilisation of Foreign Pilots/Engineers on BA aircraft: Regulations permitting employment of foreign aircrew/engineers for business aviation aircraft should be made simpler and seamless to ensure optimal utilisation. Likewise, DGCA should expedite approvals of foreign OEM and MRO applications and make the procedures more user-friendly.

Creation of a Strategic Governing Board: MoCA should take the lead by forming a joint coordination strategic committee with representatives from Defence, Home and other relevant ministries to address this legitimate concern of the industry. Professionals visiting India for the purpose of operations/engineering related work in civil aviation need to be expeditiously facilitated at airports and other Government offices. All Government offices should be sensitised by MoCA through the PMO office, on the importance of expeditious decision making in aviation matters.

Separate regulations for Fixed/rotary wing, BA sub-sectors: It is time the DGCA comes out with specific and proportionate regulations governing BA operations and develop standard operating procedures (SOPs) for helicopter operations covering all roles that these helicopters are capable to perform. A dedicated BA cum rotary wing division must be set up and cover all departments of DGCA, directly under a JDG level officer. Separate regulations for BA including helicopter operations is the need of the hour as this will greatly improve the operating environment for all sectors.

Separate routes/air corridors for helicopters: DGCA should permit the use of Performance Based Navigation (PBN) for helicopter operations. PBN helps aircraft fly closer together with the aid of creative 3D takeoff and landing approaches. This will greatly help in decongesting the clogged airspace by supporting smaller separation intervals between aircraft. In collaboration with the AAI, the DGCA should establish separate routes and air corridors for helicopters at all major airports.

Rationalisation of airport charges: AERA must clearly demarcate between aeronautical/non-aeronautical services at an airport and ensure that the user charges being levied by Indian airports for providing services to BA are appropriate, fair and consistent with the quality of services rendered.

The Global Helicopter Market

Over the next five years

Leonardo's new range: the AW 169, AW 189 and AW 139

In the face of slowing global economic growth and increased volatility in oil and gas-related markets, the helicopter industry is taking a cautious outlook for near-term new purchases. In its 18th annual *Turbine-Powered Civil Helicopter Purchase Outlook,* Honeywell forecasts that 4,300 to 4,800 civilian-use helicopters will be delivered from 2016-17 to 2020-21, or some 400 helicopters less than the 2015 five-year forecast.

"The current global economic situation is causing fleet managers to re-evaluate new helicopter purchases and that is why we are seeing a more cautious five-year demand projection compared with previous years," said Carey Smith, President, Defence and

India's HAL Dhruv

Airbus Helicopters EC155

Space at Honeywell Aerospace. "Even in a slower growth environment, Honeywell is well-positioned to help operators keep current fleets last longer with upgrades and repairs."

The survey showed that new purchase-plans were stable, but operators cited fewer total new model purchases over the five-year period, leading to a more cautious near-term outlook. When considering a new purchase, operators' results mirrored those from the previous forecast, with model choices for their new aircraft most strongly influenced by range, cabin size, performance, technology upgrades and brand experience. Helicopter fleet utilisation generally declined compared with the previous forecast. Over the next 12 months, usage rates are expected to improve but at a reduced rate. Helicopter fleet utilisation reported in the survey generally declined compared with the previous period. Over the next 12 months, usage rates are expected to increase but at a reduced rate.

In India and Brazil, new helicopter purchase-plan rates actually exceed the world average by a wide margin, but Chinese purchases have slipped, reflecting near-term slower economic growth prospects. Notably, no Chinese-built models received purchase interest mentions in the survey; however, civil deliveries are occurring and are reflected in the Honeywell outlook.


Bell 525 Relentless

The Military Rotorcraft Market

The global military rotorcraft market, valued at US$21.7 billion in 2016, is projected to grow at a CAGR of 2.59% over the forecast period, to reach US$28.1 billion by 2026 and cumulatively value US$254.2 billion. The market consists of four categories: multi-mission and maritime helicopter, attack helicopter, transport helicopter, and training helicopter. The market will be dominated by the multi-mission and maritime helicopter segment, which is expected to account for 44.6% of the market, followed by attack, transport, and training helicopters, with shares of 28.5%, 25.2%, and 1.7% respectively.

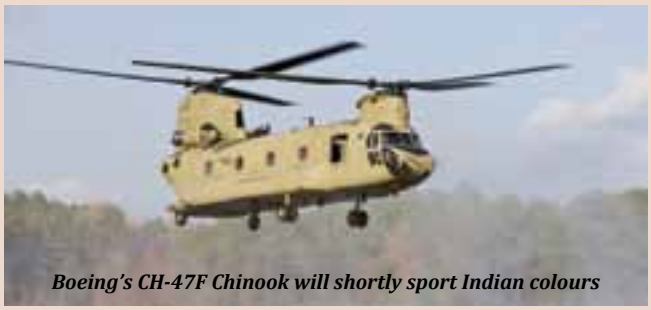
Countries in the Asia Pacific region are expected to account for the highest spending on military rotorcraft accounting for 34.2% of the market, followed by North America, which will take 30.2%. China's growing assertiveness in territorial disputes with its neighbours, an ongoing arms race among Asian countries, and strong economic growth are the primary drivers of the region's rotorcraft requirement which is forecast to grow at a CAGR of 3.41%, to reach US$8.8 billion by 2026. At the same time, the US is investing in advanced rotorcraft development programmes to maintain its military supremacy over other countries, and is expected to drive the overall spending of North America, to US$76.8 billion cumulatively throughout the forecast period.

Boeing's AH-64E Apache: on order from the Indian Air Force

Europe, which remains the third largest market, is emerging from an economic crisis and is expected to witness only marginal growth in the forecast period; the region is expected to account for 20.7% of the total market.

The Middle East region is expected to be one of the fastest growing markets for rotorcraft with a CAGR of 6.84%. South American countries such as Brazil, Chile, Venezuela and Colombia are also expected to modernise their fleets as they look to establish military supremacy in the region. The market is expected to increase at a CAGR of 3.96% over the forecast period, cumulatively accounting for 2.9% of the total market. Demand in Africa is expected to grow moderately over the forecast period, with the region accounting for only 2.5% of the total market size.

An IAF Mi-17V-5



Boeing's CH-47F Chinook will shortly sport Indian colours

Many countries across the world have inventories of obsolete or aging military helicopters that are reaching the end of their operational life; which means that despite budget cuts, the global military rotorcraft market is expected to grow. Countries such as Russia, the US, France, Germany, China, South Korea and India are looking to replace existing military rotorcraft with modern helicopters, which in turn will boost the overall demand.

Russian Helicopters Ka-226 are to be produced in India

Airbus Helicopters AS565 MBe Panther is in competition to meet the Indian Navy's requirements

The Global Military and Commercial UAV Market

The global military UAV market is projected to grow to USD 13.9 billion by 2026, at a CAGR of 38.7% from 2016 to 2022. MUAV/MAVs are dominant in respect of units delivered and the UCAVs in terms value. There has been a growing use by militaries around the world of Unmanned Aerial Vehicles, more popularly known as 'drones'. More than 10,000 UAVs are now operated or coming into service with militaries around the world. Their increased usage has mostly been driven by operational experience of the US and Israel, as well as recent operations in Afghanistan, Iraq and Syria for intelligence, surveillance and reconnaissance (ISR) tasks with the US leading the way in terms of spending on research, procurement and support. Several countries are gaining and developing their own platforms in part to enhance their military intelligence capabilities, or in order to develop their own defence and aerospace industries.

MBDA'S Brimstone missile planned for RAF's Protector RPAS

MBDA's Brimstone precision strike missile is being planned as the UK's guided missile solution for the Royal Air Force's Protector Remotely Piloted Air System (RPAS) programme. Once ordered, the General Atomics Aeronautical Systems Inc (GA-ASI) Certifiable Predator B will enter service with this weapon. The integration plan is included as part of the Ministry of Defence's Main Gate selection of the aircraft and, if agreed, the missile will be integrated and fielded in line with the platform's introduction to service.

MBDA will work together with UK MoD, US DoD and GA-ASI towards a programme which would see the missile undergo integration onto the air system with trials and firings towards the end of the decade. The missile has already successfully completed a series of trial firings on MQ-9 Reaper during early 2014 that saw the weapon engaging 70mph and manoeuvring targets with extreme precision from the RPAS; unmatched by any other weapon since. The missile promises to arm Protector with the ability to strike fast moving, manoeuvring targets with both man-in-the-loop post launch guidance and also autonomous, post launch, all weather capabilities. This confirms that the missile is a true multiplatform weapon that can operate across fast jets, RPAS and, most recently, helicopters.

Today, unmanned aerial systems are increasingly used by police departments, border patrol, oil and gas industries and other such utilities, which is driving the market across the globe. In addition to this, unmanned aerial systems are being used in agriculture sectors, made possible owing to the intensive R&D carried out, thus, broadening the application scope of the UAVs.

The global unmanned aerial systems (UAV) market is boosted by technological advancements and the need to carry out complex operations. UAVs reduce the need for human intervention and this drives their demand further. Moreover, unmanned aerial systems have been successful in several combat operations which is fueling their demand especially from the Middle East, Asia–Pacific, and North American countries. The navigation and visualisation aids offered by unmanned aerial systems or drones will help the market to grow. Unmanned aerial systems allow mapping and also enable inspection or surveillance from the air. Since UAVs can be fitted with cameras, they are able to carry out operations discreetly.

On the other hand, diminishing budgets for defence in countries of Europe and North America will hamper growth of the market to a large extent. A lack of skilled operators also poses a challenge for global unmanned aerial systems. In addition, stringent airspace regulations will further impede growth of the unmanned aerial systems market. However, despite all these challenges, experts say that the rising investments in research and development in the field of unmanned aerial systems will improve the efficiency of these systems. Operational efficiency along with added features owing to advancements in technology will help the market to overcome challenges and grow in the coming years.

Key players in the market are Elbit Systems Ltd. (Israel), AeroVironment, Inc. (US), Safran SA (France), GA-ASI (US), Lockheed Martin (US), BAE Systems (UK), Northrop Grumman Corporation, Textron Systems (US), Saab AB (Sweden), Boeing (US), and Aviation Industry Corporation of China. Product launches to stay ahead of other players, expands the competition. Extensive investments are being made on research and development to enable product enhancements and improvements. With the advent of new technologies on a continuous basis, players are striving hard to gain competitive edge against the rest.

Thales and Royal Navy test unmanned systems

Thales has announced its "major role" in an extensive Royal Navy demonstration to determine the feasibility of using unmanned systems in a maritime environment. *Unmanned Warrior*, the largest demonstration of its kind in the UK, brought together Thales and around 40 participants from the Ministry of Defence, industry and academia to assess unmanned systems in a realistic military setting. The key Thales systems were the Watchkeeper unmanned air system (UAS) and the Halcyon unmanned surface vessel (USV).

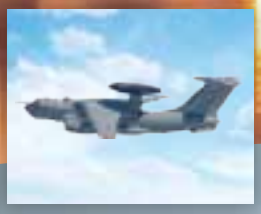
Watchkeeper unmanned air system (UAS)

For the first time, Watchkeeper will be deployed in a maritime role using its I-Master radar to track small, fast incoming asymmetric threats, such as jet skis and high speed craft. Watchkeeper has previously only been used for essential land-tracking operations such as operations in Afghanistan. Watchkeeper can offer the Royal Navy an immediate and assured Intelligence Surveillance Reconnaissance (ISR) operations in capability with an extended endurance of over 16 hours.

Meanwhile, Halcyon demonstrated its remote mine-hunting capabilities after recently completing successful trials of towing a Thales Synthetic Aperture Sonar (T-SAS). Halcyon and T-SAS will be tasked with identifying and mapping undisclosed minefields during the exercise. The Halcyon USV is being developed as part of the Thales-led consortium solution for first phase of the Anglo-French Mine Countermeasures programme to assess the future mine warfare capabilities of the UK and French navies.

Halcyon unmanned surface vessel (USV)

MAKE IN INDIAI



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The Relentless Pace of UAV Development

Predator-series exceed 4 million flight hours

General Atomics Aeronautical Systems, Inc. (GA-ASI), a manufacturer of Remotely Piloted Aircraft (RPA), radars, and electro-optic and related mission systems solutions, has announced that its Predator-series family of aircraft, including MQ-1 Predator, MQ-9 Reaper, and MQ-1C Gray Eagle, achieved a historic industry milestone: four million flight hours.

Identification of the specific aircraft and customer that achieved the milestone is not revealed as every second of every day, an average of 70 Predator-class aircraft are airborne worldwide. Flight hours have continued to grow at unprecedented rates in recent years, with 500,000 flight hours achieved from 1993 to 2008, one million hours in 2010, two million hours in 2012, and three million hours in 2014. Recently GA-ASI's Predator B/MQ-9 Reaper fleet passed its own historic milestone, achieving one-and-a-half million flight hours, after flying approximately 111,773 total sorties. Predator B/MQ-9 Reaper flight hours now account for approximately one-third of GA-ASI's four million total flight hours and are increasing at an average rate of 32,000 hours a month.

Leonardo-Finmeccanica's SW-4 'Solo' Rotary UAV

Leonardo has demonstrated the capabilities of its advanced SW-4 'Solo' Rotary Unmanned Air System as well as its airborne sensors such as the SAGE electronic warfare and Osprey E-Scan radar systems integrated using its skyISTAR mission management system in order to support intelligence, surveillance and reconnaissance missions. The company has been investing in unmanned rotorcraft technology which it believes can deliver or contribute to the delivery of a wide range of missions cost effectively and also complement its range of manned naval helicopters. The SW-4 'Solo' Rotary Unmanned Air System (RUAS) is based on the SW-4 light single engine helicopter. It is designed for both piloted (Optionally Piloted Helicopter, OPH) and unmanned operations, for maximum operational flexibility. The RUAS version of the SW-4 is capable of performing a number of roles, including intelligence, surveillance and reconnaissance and cargo re-supply, in both land and naval environments. When piloted, the SW-4 'Solo' can undertake manned activities including transportation of personnel, surveillance and intervention.

European MALE RPAS programme takes off

Since beginning of September 2016, the development of a common European drone has entered a new phase. The contract for the Definition Study of the European MALE RPAS (Medium Altitude Long Endurance Remotely Piloted Aircraft System) Programme, assigned to Airbus, Dassault Aviation and Leonardo-Finmeccanica was launched at a kick-off meeting chaired by the *Organisation for Joint Armament Cooperation* (OCCAR) with the attendance of the programme participating States France, Germany, Italy and Spain.

MALE RPAS will be a new generation remotely piloted air system for armed Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) missions. Air traffic integration and certification for European densely populated environment are part of the key distinctive objectives of the programme. The two-year definition study started from September 2016 and will be jointly executed by Airbus Defence and Space, Dassault Aviation and Leonardo-Finmeccanica Aircraft Division with an equal work allocation. The three companies are co-contractors to perform the definition study. Following the study, the start of the development phase is planned for 2018, with a prototype first flight in early 2023 and a first delivery of the system in the 2025 timeframe.

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DCNS and Airbus Helicopters to design future VTOL drone

DCNS and Airbus Helicopters will jointly design the future tactical component of France's Naval Aerial Drone (*Système de Drones Aériens de la Marine* - SDAM) programme. By pooling naval and aerospace skills and expertise, the teaming of DCNS and Airbus Helicopters will be equipped to address all technical challenges arising from the naval integration of the drones through the creation of a robust system architecture that can evolve and adapt to meet varied needs.

DCNS's role in the partnership will be to design and supply the entire warship-integrated VTOL drone system. DCNS will design and develop solutions for the ship-based operation and integration of the drone, including the specification and validation of the payloads and mission data links. DCNS will also produce the drone's mission system, which will enable real-time management of its operations and allow its payloads to be controlled through the combat management system.

The VSR700 has been developed by Airbus Helicopters with a view to providing military customers with a solution that leverages a tried and tested civil aircraft and strikes the best possible balance between performance, operational flexibility, reliability and operating costs. Harnessing autonomous flight technologies that have been tested by Airbus Helicopters through a range of demonstration programmes, the VSR700 is derived from a light civil helicopter, the Cabri G2 (developed by Hélicoptères Guimbal), which has proven its reliability and low operating costs in service. Under the terms of the partnership, Airbus Helicopters will be responsible for designing and developing the VSR700 drone as well as the various technologies needed for drones to perform aerial missions, such as data liaison, payload and a 'see and avoid' capability enabling the drone's integration into airspace.

Elbit reveals its ReDrone

Elbit Systems has revealed its ReDrone system, designed to detect, identify, track and neutralise different types of drones that are flown within a range of radio frequency communication protocols. The ReDrone's open system architecture allows multiple hardware configurations, including an array of controllers and sensors for target detection, tracking and engagement. The system is also capable of separating a drone's signals from its operator's remote control signals, as well as pin–pointing both the drone and the operator's directions. The advanced detection system provides 360-degree perimeter protection and complete, up-to-the-minute situational awareness. It can also deal with a number of different drones simultaneously. Owing to its advanced passive detection features, ReDrone also enhances environmental protection and supports the safety of civilians and air platforms inside the secured airspace.

After detecting a target, the ReDrone system disrupts the drone's communication with its operator, blocks its radio and video signals and GPS positioning data, and sends it off track, preventing it from carrying out an attack. ReDrone's infrastructure is designed for easy and rapid installation in different application areas and terrains, and is suitable for operation in all weather conditions. Its digital control unit, which is based on Android, features an easy-to-use, intuitive user interface.

FMS of Certifiable Predator B Remotely Piloted Aircraft to UK

The US State Department will be approving a possible Foreign Military Sale to the United Kingdom for Certifiable Predator B Remotely Piloted Aircraft, equipment, training, and support at an estimated cost of $1.0 billion. The United Kingdom (UK) requested a possible sale of up to twenty-six (26) Certifiable Predator B Remotely Piloted Aircraft (16 with option for additional 10); twelve Advanced Ground Control Stations (GCSs) (8 with option for additional 4); four New Launch and Recovery Element GCSs; four Upgrades to existing Blk 15 Launch and Recovery Element GCSs (2 with option for additional 2); twenty-five Multi-spectral Targeting Systems (12 + 2 spares, with option for additional 10 + 1 spare); twenty-five AN/APY-8 Lynx IIe Block 20A Synthetic Aperture Radar and Ground Moving Target Indicators (SAR/GMTI) (12+ 2 spares, with option for additional 10 + 1 spare); Eighty-six Embedded Global Positioning System/Inertial Guidance Units (EGIs) (3 per aircraft) (48 + 5 spares, with option for additional 30 + 3 spares).

ScanEagle completes Maritime surface search

With the number of flight hours rapidly approaching one million, Insitu's ScanEagle platform continues to pioneer iterative innovation. At the Royal Navy's recent *Unmanned Warrior* demonstration, Insitu showcased its newest wide-area maritime surface search and identification technology to representatives from the Royal Navy as well as military and industry officials from across the globe. During the event held in Benbecula, Scotland, the Insitu team was tasked to perform a range of maritime missions using ScanEagle equipped with the ViDAR payload. Developed in collaboration with Australia-based Sentient Vision Systems, ViDAR is the only maritime surface search with automatic target finding capability on a group two unmanned platform.

Key accomplishments at *Unmanned Warrior 2016* included: ScanEagle flew more than 55 hours, covering an area more than twice the size of Wales (41,500 km²) and using fewer than eight gallons of fuel; despite sometimes challenging weather, ScanEagle with ViDAR autonomously detected hundreds of large and small objects in sea state six conditions. These included spotting and positively identifying two mine sweepers by number, spotting smaller objects such as stationary jet skis and buoys at 5 nm and locating 28 contacts from one sortie in fewer than two hours; ViDAR successfully and reliably detected objects through changing environmental conditions ranging from clear sun to wind, rain, haze and fog and finally ScanEagle flew more hours than any other participating platform.

In May 2016, Sentient and Insitu had confirmed the formalisation of an exclusive global distribution agreement for the ViDAR software for unmanned systems within the small UAS weight class. ScanEagle is the first and only unmanned platform to fly this payload.

Kishore Jayaraman, President, Rolls-Royce, India and South Asia writes on

Rolls-Royce in India: "Co-creating the future together"

India today is not only one of the world's top 10 defence markets in terms of import, but also is one that is growing at a steady rate, aided by several policy reforms and initiatives by the Government. With more than 750 engines in service with the Indian Air Force and Indian Navy, we are currently playing an important role in mission-readiness and the modernisation of India's defence forces. Our engines power a wide variety of aircraft in the inventory of the Indian military – from combat and strike aircraft (the Jaguar, powered by the Adour Mk811) to trainers (Hawk Advanced Jet Trainer, powered by Adour Mk871) to strategic airlift aircraft (C-130J Hercules, powered by AE2100) and even VVIP and Surveillance aircraft (ERJ145, powered by the AE3007). The Hawk Advanced Jet Trainer, which trains the next generation of Indian pilots, recently clocked 100,000 flying hours with the Indian Air Force.

Our Adour Mk804/Mk811 engines are powering Jaguar and were made, and continues to be supported, in India today by HAL, with Rolls-Royce support. This long-standing relationship with HAL has evolved further into a joint venture - International Aerospace Manufacturing Pvt. Ltd. (IAMPL), which was set up in 2013 to manufacture a wide range of engine components including compressor shrouds and cones for our gas turbines which are used globally. This is an excellent example of Rolls-Royce's long-term commitment in developing the Indian aerospace industry and delivering self-reliance for India.

With about ten engine types in service with the IAF and IN, we provide a wide range of support solutions ranging from the provision of 24x7 technical advice, through supplying spares and material, right up to Mission Care which provides a complete support solution to the Indian customer. Our field service representatives (FSRs) work in close support with Armed Forces personnel to maximise the availability of engines on wings and provide on-ground

technical advice directly to our customers, thereby drastically reducing maintenance and overhaul times. Over the years, we have played a vital role in supporting the growth of the Indian aerospace industry with our large portfolio of products and services and the right combination of experience and advanced technologies.

India's inherent advantages such as skilled talent and competitive costs, coupled with the country's economic strengths and its focus on modernisation and infrastructure development, makes it an attractive and strategic growth market for us. The country is in a position to build a vibrant local defence industry ecosystem that could support both domestic and export demand.

This is a key reason for us to set up two engineering centres in India, one in Bengaluru where we carry out a range of aerospace design and engineering work including development of new tools and technologies; and the other in Pune, where we launched an integrated engineering centre which delivers excellent engineering solutions to our Marine and Power Systems businesses. Both these centres, which will grow to over 14,000 square meters by end 2017, demonstrate our long-term commitment to strengthen our distinguished legacy and play a major role in helping develop India's capabilities.

Concerning the supply chain, we are currently sourcing rings and forgings from amongst suppliers owned or operated by local entities such as Bharat Forge, Godrej and Tata as well as our own joint venture IAMPL. We also plan to increase sourcing for existing commodities as well as expanding into more complex commodities in the future.With this growing footprint, we are looking at building an ecosystem that will engage in co-creation across the entire value-chain – from research, design and development to manufacturing, maintenance and repair. For India, it would mean a further impetus on its 'Make in India' initiative to strengthen its R&D and access to advanced technologies and products.

India's defence industry is today at a crucial juncture of modernisation, reforms and technology, each being instrumental in driving the growth and stability of the sector. The country's vision to achieve better defence preparedness, own advanced technology, robust manufacturing footprint and create highly skilled workforce offers immense opportunities for MNCs as wells as private domestic players to be a part of this emerging growth story.

Our global experience and best practises that stem from supporting 160 armed forces in 106 countries, gives us a unique opportunity to better support this growth. Overall, we are looking at a number of different programmes in India and will continue to realise the country's growth vision and efforts to indigenisation and modernisation. With technology transfers and wide array of innovative products and technologies, Rolls-Royce will continue to remain committed to support India achieve its vision of becoming self-reliant and globally competitive. We nurture a cooperative and strong association with our local partners and looking to the future, we are ready to embrace opportunities to co-create, co-develop and co-manufacture in India and face the future with confidence.

Su-30MKI: The next stage

This year, the Su-30MKI programme will celebrate its 15th anniversary. The IAF received its first Su-30MKI on 27 September 2002, and over the next decade and a half, the fighter has become backbone of the IAF's combat air power, while Indian industries made major strides in development of aircraft production capabilities. The programme became a keystone of the military-technical collaboration between India and Russia. The close co-operation achieved through the Su-30MKI programme was extensively leveraged for further Indo-Russian partnership across new joint projects, which will have defining impact on the Russian and Indian aviation industries into the 21st Century.

The major pre-requisite of the Su-30MKI programme was the strategic partnership between the countries. Indo-Russian ties in the military-technical sphere have steadily developed over time, "and are rarely ever affected by political pressure, discrimination or embargos." The Su-30MKI is a prime example of the evolution of a relationship that began with simple 'customer-seller' interaction, and has since grown to joint development. The programme's success was largely owed to the fact that it combined state-of-the art expertise available in each of the two countries. The Indian military had formulated their vision for a new fighter, which was based on the approach required to tackle futuristic combat environments. Russian designers integrated modern technologies such as phased array radar and thrust vectoring engines into the aircraft, creating a combat system that has become one of the premier heavy fighters of the world. IAF pilots have demonstrated the Su-30MKI's capabilities at military exercises around the world, more than matching the best contemporary fighters.

Also important is the fact that the programme participants chose their priorities correctly. Irkut Corporation President Oleg Demchenko states, "From the very beginning we were quite certain that the programme's aim was not only to provide the IAF with modern combat fighters, but also to develop technological cooperation between aviation industries of our countries."

In early phases of the programme, HAL mastered domestic production of the Su-30MKI, and today 80 per cent of the fighter is "made in India." Actually, the Su-30MKI is manufactured in India from raw materials, while Indian-made avionics are supplied to foreign Air Forces that have opted for Su-30 family aircraft. Russia has been a strong proponent of 'Make in India,' which has been demonstrated through the Su-30MKI programme and a range of scientific and technical collaborations between India and Russia that have benefited from the experiences of this project.

The Su-30MKI programme has entered a new stage, centred on after-sales support and further development of the fighter. Aircraft from the first batches, delivered in the early 2000s, have already been overhauled at HAL facilities, and increasing in-country repair and overhaul capacities

Victor Bondarev, Commander-in-Chief of the Russian Aerospace Forces and Irkut President Oleg Demchenko at the ceremony for handing over of Su-30SM fighters to the 'Russian Knights' aerobatic team

are a key objective for the future. This will allow all stakeholders to prolong the service life of the Su-30MKI with the IAF. Talks on modernisation of the platform are underway, and the Su-30MKI has already ben united with another key Indo-Russian project — the BrahMos supersonic cruise missile. Completion of BrahMos integration will see the Su-30MKI receive a peerless strike capability that will also enhance the type's export potential.

It is important to note that since 2012, the Russian Air Force and Russian Naval Aviation have been procuring the Su-30SM, a localised derivative of the IAF's Su-30MKI, which could make a collaborative upgrade project for the platform even more viable, allowing it to serve in Russian and Indian colours well into the future.

Irkut officials are sanguine that India is the Company's most important foreign customer, with whom cooperation first commenced in the early 1980s, at which time HAL was manufacturing MiG-27ML strike aircraft under licence from the Irkutsk Aviation Plant. Irkut President Oleg Demchenko stresses on the fact that 35 years of mutual understanding forged between Russian and Indian specialists through multiple programmes contributed to the Su-30MKI's success, and could be leveraged further: "We may use our experience in co-operation for new projects, like the MC-21 airliner."

IAF Su-30MKI pilots at the Red Flag exercise in the USA (photo: K Tokunaga)

The entire range of Russian-origin aircraft in Indian service could benefit from this change (photo: Angad Singh)

UAC to directly provide Foreign Sales and Support

On 28 November 2016, Russia's Federal Service on Military-Technical Cooperation (FSMTC) cleared United Aircraft Corporation to directly provide after-sales spares and support of all previously contracted Sukhoi, MiG, Ilyushin, Yakovlev and Tupolev aircraft. The list includes a wide range of aircraft types and variants, including a number of India-specific models such as the Sukhoi Su-30MKI, MiG-29UPG, MiG29K/KUB, MiG-21 and MiG-27 variants, the Il-38SD maritime patrol aircraft and Il-78MKI tankers.

This also allows UAC to upgrade and modernise previously supplied aircraft, render training services for foreign pilots and technical staff, and crucially, to establish aftersales support and repair joint ventures abroad. Readers will recall several such proposals in the Indian context in the recent past (*see Vayu I/2016*).

"It is hoped that the certificate will allow UAC to better coordinate work in this field, to develop a company-wide corporate after-sales and service system based on past experiences as well as global best practices, and enable maximum efficiency in markets where multiple UAC brands are present (such as India)."

Small, highly specific sub-fleets, such as the Indian Navy's Il-38SD patrol/ASW aircraft will likely benefit with improvements in availability (photo: Angad Singh)

BrahMos : a Hypersonic Future?

At Aero India 2013, the BrahMos Pavilion included a mock-up of the futuristic hypersonic 'BrahMos II' missile. When this *Vayu* observer commented that the missile appeared to be "science fiction," a visibly pleased Dr Sivathanu Pillai, who was then Chief Executive Officer (CEO) of the Indo-Russian BrahMos Aerospace joint venture, smilingly asserted that "we are going to make this science fiction a reality." He further set the timeline of induction of the missile to around 2020.

While the design remains based on (albeit highly modified) Russian-designed NPO Mashinostroyenia 3M55 Yakhont (SS-N-26), to keep the technology "secret," the hypersonic BrahMos will be only operated by the armed forces of India and Russia. A series of lab tests of the missile's three projected variants – ground-launched, airborne, and sea-launched – have already been carried out at simulated speeds of Mach 6.5. The missile, with a prominently raked nose, is projected to attain a top speed of Mach 7 and is likely to be able to deliver its payload (possibly rocket propelled 'darts' of even greater velocity), perform Battle Damage Assessment (BDA) and return to base, thereby playing the role of an Unmanned Combat Aerial System (UCAS). In air-launched mode the missile will acquire further lethality if it can be accommodated in internal weapon bays of the launch aircraft. India's Aeronautical Development Agency (ADA) would do well to modify the proposed Advanced Medium Combat Aircraft (AMCA) to a medium stealth bomber capable of accommodating two hypersonic BrahMos in internal weapon bays, further complemented by Close Combat Missiles (CCM) for self-defence. Needless to say, the submarine launched version (launch platforms are likely to be variants of *Arihant*-class nuclear powered submarines) promises to be its deadliest variant providing no clue prior launch of the 'bolt from the blue' weapon, yet executing the mission in a matter of ten to fifteen minutes.

A separate centre has been created at the Indian Institute of Science while its Russian counterpart, the Moscow Institute of Aviation, is producing technologies for propulsion and kinetic energy modules for the hypersonic BrahMos variant. The Mach 7 missile will require a major technological breakthrough by the Russians in the context of propulsion components hitherto comprised of a solid-fuel booster and liquid-fuel ramjet engine. High sustained speeds will be ensured by a Supersonic Combustion Ramjet (Scramjet) that burns hydrogen fuel in a stream of supersonic compressed air created by the forward motion of the missile, resulting in hypersonic speed and immense kinetic energy for destruction of hardened or deeply buried targets, such as Nuclear, Biological and Chemical (NBC) weapon storage facilities. If developed in combination with a passive radiation homing seeker, the missile will fulfill an Indian Air Force and Indian Navy requirement for a formidable Suppression of Enemy Air Defence/Destruction of Enemy Air Defence (SEAD/DEAD) weapon. It will also pose a deadly threat to enemy warships sporting elaborate air defence radar systems, like the Aegis-type vessels under construction for the Chinese People's Liberation Army Navy (PLAN). More radical concepts may include a reconnaissance drone variant that, after penetrating heavily guarded enemy airspace, will be in position to transmit real-time data to friendly ground stations before ultimately destroying itself at the termination of its flight.

Adding an element of surprise, Sudhir Kumar Mishra, the current BrahMos Aerospace CEO, recently revealed existence of a projected Mach 10 variant. He further stated, "The late President APJ Abdul Kalam, also known as 'India's Missile Man,' had dreamt of a high-end missile programme that could be reused, as the mythical *Sudarshan Chakra* is believed to have been. It is a highly challenging project but the technological advancements by Indian scientists in the field of supersonic missiles have the capacity to accomplish it." Mishra also asserted that the timelines for induction of hypersonic BrahMos variants are likely to be achieved.

Sayan Majumdar

Dassault Aircraft Business in 2016

In January 2017, Dassault Aviation released production and delivery information covering the previous year's military and civilian business, ranging from Rafale multirole fighters to Falcon business jets. 36 Rafales were ordered for export in 2016, following the execution of the contract with India, compared to 48 ordered in 2015 (24 each for Egypt and Qatar). "This new order once again demonstrates the Rafale's successes."

Meanwhile, 33 Falcon business jets were ordered in 2016 but 12 Falcon 5Xs were cancelled, compared to 45 Falcons ordered and 20 Falcon Netjets cancelled in 2015. "The weakness of the order intake reflects a difficult business jets market," according to a Dassault spokesperson.

Deliveries in 2016 included 9 Rafales (6 to France and 3 to Egypt) in line with Dassault's forecasts, compared with 8 Rafale deliveries (5 to France and 3 to Egypt) in 2015. In addition, Dassault delivered two Rafale M fighters, retrofitted to the F3 standard for the French Navy.

49 new Falcon business jets were delivered in 2016, as per a forecast of 50 Falcon deliveries, compared to 55 delivered in 2015.

As on 31 December 2016, Dassault's consolidated backlog included 110 Rafales (32 for France and 78 for export) and 63 business jets, compared to 83 Rafale (38 France and 45 Export) and 91 Falcons as of 31 December 2015.

Falcon 8X

2016: "A landmark year for Thales in India"

In conversation with Stephane Lavigne, Thales, VP S&M–India, he states, "As we have stepped into 2017, it gives an opportunity to look back and reflect on the past year for Thales in India. With a rich legacy of over six decades in India, Thales has been contributing significantly towards the growth story of the country. The year 2016 saw some key milestones in Thales's successful ongoing partnership with India, both industries and armed forces.

One of the significant developments of 2016 was the contract for 36 Rafale aircraft for the Indian Air Force (IAF). Thales, a member of the Rafale team, alongside Dassault Aviation, provides a number of state-of-the-art equipment and systems aboard the Rafale. These include the provision of RBE2 AESA radar, the Spectra electronic warfare system, optronics, the communication navigation and identification system (CNI), the majority of the cockpit display systems, power generation systems and a logistics support component. Rafale's new export success demonstrates Thales' ability, alongside Dassault Aviation and its partners, to constantly meet the customer's highest expectations through innovation, mastery of advanced technology and industrial excellence. This contract will create hundreds of jobs on Thales manufacturing sites in France, as well as for numerous partners and sub-contractors in India and France.

Another key highlight of the year was the signing of a partnership agreement between Thales and BEL-Thales Systems Limited (BTSL) for joint development of the PHAROS fire control radar that will meet requirements of armed forces in India and in other global geographies. The Joint Venture (JV)company - BTSL attests to the long and successful working relationship that Thales has had with Bharat Electronics Limited (BEL).

The company also has a JV with Samtel for military avionics and airborne sensor systems and with L&T Technology Services for avionics software. This is in addition to the long term partnership that Thales has with HAL – both have been working closely for over 50 years now. Further in line with the 'Make in India' policy, Thales has been co-operating with the Indian private sector particularly large corporate players, SMEs and MSMEs to build transfer of technology and supply chain partnerships for Indian as well as for international markets. These associations underline Thales's long-term commitment to India and its plans to enhance its industrial footprint in the country.

Stephane Lavigne, VP S&M – India, Thales

Taking forward its participation in the modernisation process of India's armed forces, Thales announced the award of a contract from BELTECH to provide Catherine thermal imaging cameras for T-90 Main Battle Tanks (MBTs) of the Indian Army in May 2016. As part of this contract, Thales is doing a transfer of production to integrate 260 compact LWIR thermal imaging (TI) Catherine into BELTECH's TI Sights that will be installed on the T-90 battle tanks of Indian Army. The Catherine thermal imager is already in service with the Indian Army and this new order consolidates Thales leadership in optronics technologies in India.

While these were some of the key highpoints, ongoing projects like the Mirage 2000 upgrade saw steady progress in 2016. Four upgraded Mirage 2000 aircraft have been delivered to the Indian Air Force. The rest of the fleet is being upgraded under the responsibility of HAL with the support of Dassault Aviation and Thales teams, as per the contract.

As a global technology leader, Thales doesn't only build defence and aerospace solutions but also invests in the future through extensive R&D initiatives. These initiatives enable Thales to remain ahead of competition and develop technologies for tomorrow. In line with this approach, Thales has been collaborating with top ranked academic institutions. In 2016, the company signed MoUs with IIT Bombay and IIT Delhi to create a PhD fellowship programme in January and September respectively.

Thales is most enthusiastic about India and the vision of' 'Make in India' which is energising the sector and paving the way for India to evolve into a global manufacturing hub and a defence exporter. The company expects this trend to continue while simplifying and accelerating the processes for the same. This will not only help Indian industries become globally competitive but will also allow companies like Thales to further support the country's modernisation needs. Through its 'Go to India' approach, Thales has an extensive experience in liaising with numerous group supply chain partners to support the local industry in India and open up growth opportunities for them.

Looking forward, the company will continue to respond to market requirements, build a strong ecosystem of partners and support the process of transforming India into a global innovation and manufacturing hub".

Enhancing the IAF's Operational Capability

"Dominating the skies with MBDA"

MICA IR on the wing tip station of a French Navy Rafale M

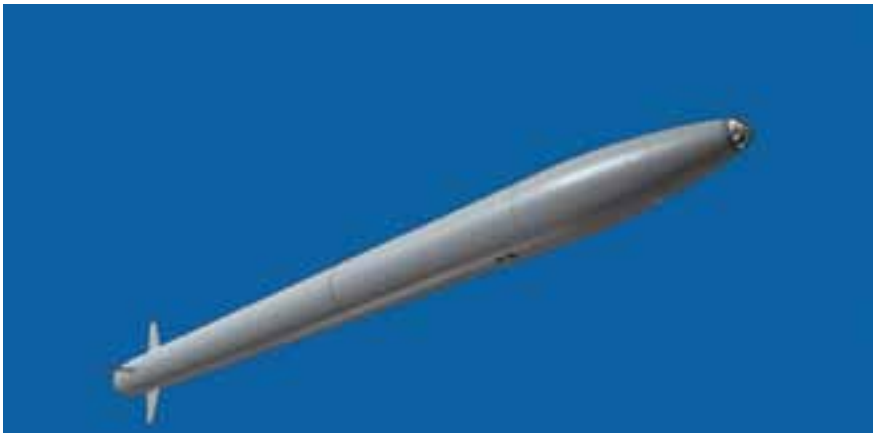
MBDA, the European leader in the guided weapons sector, has been enhancing the IAF's operational capability for many years which is well known by the Mirage 2000 and Jaguar pilots. For many years, MBDA has provided short range air defence capability for the Jaguar and both short and medium range air-to-air capabilities for Mirage 2000s. These weapons, the Magic II with its infrared seeker and the longer range Super 530D with its semi-active radar seeker, have provided such lethality for nearly four decades. However, operational requirements are continually changing and evolving to meet ever growing challenges.

Today's combat pilot is often required to carry out multiple roles that are much more complex and demanding than before. To respond to these needs, MBDA continues to support the IAF with a new generation of state-of-the-art weapons to enhance the operational capabilities of its fleet of Jaguar and Mirage aircraft, while also planning for induction of the Rafale MMRCA. "These vital projects offer MBDA the opportunity to forge even closer ties than before."

The MICA has been ordered for the IAF's Mirage 2000 upgrade to replace the Magic II and the Super 530D. It is also a weapon system closely associated with the Rafale, the only missile in the world featuring two interoperable seekers (active radar and imaging infrared) to cover the spectrum from close-in dogfights to beyond visual range. Its ability to operate the BVR in passive mode before the seeker locks on in the final stages of the end game has earned it the tag of being a 'silent killer', as the target has little time to react or to deploy effective countermeasures.

The ASRAAM has been selected for the IAF's Jaguar fleet which is currently undergoing major upgrades. ASRAAM's speed not only provides safe separation from the Jaguar's above-wing pylons, but also guarantees 'first shot first kill' to avoid getting involved in a dogfight. As the Jaguar is a low-flying aircraft, threats arise from more agile fighters with altitude superiority and ASRAAM offers a major advantage here with its unmatched 'snap-up' capability, its ability to rapidly swing 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 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 ahead.

For the IAF too, operational performance is what matters. Taking a wider view, India is moving towards industrial autonomy as reflected in the 'Make in India'



MBDA's ASRAAM

policy of the Government. Both MICA and ASRAAM incorporate significant inputs by Indian companies which has helped MBDA to increase its growing network of defence sector business partners throughout the world.

MBDA, which probably has the largest portfolio of guided weapon systems of any company in the sector, is also supporting the IAF in the Rafale programme. MICA, already in the IAF's inventory, is a key weapon for the Rafale. With Meteor having entered service with Gripens of the Swedish Air Force, this next generation weapon is also factored in Rafale's future armament. The Meteor has been designed to be many times superior to the most sophisticated current and emerging Medium Range Air to Air Missile (MRAAMs) threats. It provides added "dissuasive power" to an air force as the enemy will think seriously before intruding into potentially lethal air space. 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 extremes of range when other MRAAMs have long since ceased being effective.

Deep strike capabilities are a major requirement for a multi-role aircraft such as the Rafale. The ability to deliver 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 early days of war as was witnessed in Iraq and Libya.

The Scalp/Storm Shadow, which is in operational service with French Air Force Rafales (as well as with other European air forces), has proved its unmatched ability to combine very long range with devastating target effect during operations carried out by air forces of the UK, France and Italy.

Another air-launched weapon of interest to the IAF is the much publicised Brimstone close combat support weapon. The capabilities of this very special, dual mode seeker equipped missile have impressed air arms around the world following its successes in combat operations in Iraq, Libya, Afghanistan and most recently in Syria. Besides demonstrating its ability to carry out surgical strikes under complex combat conditions where collateral damage needed to be avoided, Brimstone has been through a series of demanding firing trials carried out from fast jets, UCAVs and attack helicopters, which 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 missions that a contemporary air force needs 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, the Brimstone Maritime 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) which are a fast emerging and worrying threat in coastal waters.

MBDA would also add 'teeth' to the IAF's helicopter fleet with weapons such as the versatile Mistral for both very short range surface-to-air and helicopter-launched air-to-air operations. Already integrated and tested on the HAL Rudra ALH WSI, the 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, the Mistral is deployed within the ATAM system, which is based on two launchers, each deploying two Mistral infrared seeker equipped missiles. Considering 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 entire flight envelope from nap of the earth to 15,000ft and at flight speeds from hovering to up to 200 knots.

"MBDA is extremely proud of its close relationship with the IAF, a relationship that goes back several decades. It is a relationship that will move forward as MBDA continues to support India's fighter with the very best of modern and next generation guided missiles and missile systems. The IAF supported by systems from MBDA, can operate with the confidence that they are very well equipped for the challenges that lie ahead", states Loïc Piedevache, Country Head-India, MBDA.

Loïc Piedevache, Country Head-India, MBDA

Order for Gripen upgrades/ tech support

Saab has received an order from the Swedish Defence Materiel Administration (FMV) for upgrades to the Gripen C/D system. The order value is approximately SEK 215 million with deliveries to take place between 2017 and 2019. To ensure effective utilisation of the 'Gripen system', and to future-proof its capabilities, this aircraft and ground systems undergo regular upgrades. The order is largely supplementary to the so-called MS20 upgrade carried out in Sweden in 2016. This new order now includes improvements to the aircraft's avionics and sensor systems such as the interface between the aircraft and pilot, upgrades to the support and training systems, equipment purchasing, as well as device modifications. Collectively, these upgrades will further increase the efficiency of the Gripen system.

"Today, Gripen C/D is the backbone of several air forces around the world and we see significant, sustained interest from the world market. Gripen's unique design enables a continuous upgrade of systems, which means that we can offer our customers the latest technology and thereby meet both current and future needs for operational capability", states Jerker Ahlqvist, head of Business Unit Gripen, within Saab Business Area Aeronautics.

The complete MS20 upgrade is now fully operational with the Swedish Air Force, and those that enable MS20 for the Czech Air Force, are on-going. MS20 provides a range of new capability options and includes new weapons, command and control functions, radar functions, and improved reconnaissance capabilities. By virtue of MS20, Gripen is the world's first fighter aircraft operational with the ramjet-powered Meteor missile, which makes this multi-role fighter one of the 'most cutting-edge systems on the market'. "As always is the case with Gripen, the customers are free to decide how, when, and to what degree they employ the new capabilities provided by the upgrade," according to the Company.

The company has also received an order from the Swedish Defence Material Administration (FMV) for continued technical support for Gripen C/Ds, the order value amounting to SEK 129 million. The order is a call-up of an option as part of a previous agreement with FMV for technical support and maintenance of Gripen's existing weapons and external stores, which was signed in March 2015. This new order secures continued technical support for the Gripen C/D regarding weapons and external stores, including, for example, support, configuration management, technical documentation, technical maintenance and modification. "This order will ensure continued efficient operations of technical support for Gripen C/D, ensuring that the customer's availability requirements are met in the best possible way," states Ellen Molin, head of business unit Gripen Support, within Saab business area Support and Services.

Taurus KEPD 350E:

the new standard in long-range precision attack

Airborne stand-off weapons are defined by their range, lethality and accuracy. To sit at the 'top table' when it comes to mission success, a weapon must excel in all three categories. To have long range but a poor effect on the target is meaningless! To trade accuracy for destructive power is also a poor compromise! The Taurus KEPD 350E, a product of Taurus Systems GmbH, a joint venture between Saab and MBDA Germany, delivers an unparalleled combination of performance parameters: long range and intelligent flight behaviour, a devastating combination of warhead and fuse technology, plus an extremely accurate and highly redundant guidance system for pin-point attacks.

In addition, the KEPD 350 is platform independent. It has been successfully integrated on a wide range of aircraft and there are no technical limitations or security restrictions to stand in the way of future integrations on new aircraft types. The missile is already in service or available for use on the Panavia Tornado IDS, Boeing F/A-18 and F-15. Integration flights with Eurofighter Typhoon and Saab Gripen have also been carried out. The KEPD 350E is designed for use with tactical fast jets, but studies have shown that other launch methods are possible. The missiles could be carried by and launched from transport aircraft, for example, and there is also the potential to develop ground- and ship-launched versions.

The Taurus KEPD 350E has an operational range of more than 500 km, the longest in its class. This gives users flexibility, and also increases the survivability of the launch platform. The missile can fly safely at low altitude thanks to its excellent navigation system. Complex, low-level flight behaviour coupled with a stealthy airframe design make the missile hard to detect and defend against.

The Taurus tandem warhead system weighs 480 kg. It comprises a shaped pre-charge and penetrator, to defeat hardened and deeply buried targets as well as protected, reinforced concrete structures. The KEPD 350 is an intelligent stand-off missile with a layer-counting and void-sensing fuse that delays detonation by sensing empty space so the warhead explodes only when it accurately penetrates a target. Because it has a pre-fragmented warhead the Taurus can also be programmed to attack area targets such as airfields, air defence systems, missile batteries and even ships in harbour.

The navigation system of the Taurus KEPD 350E is one of its most important features. Known as Tri-Tec, it consists of IBN (image-based navigation), TRN (terrain-referenced navigation) and MIL-GPS (military Global Positioning System), which are supported by INS (Inertial Navigation System). IBN utilises aerial/satellite image data plus coordinates of specific regions located along its flight route. Once launched, the navigation system identifies its current location by scanning the terrain with its IR seeker. It compares the results with the image data and coordinates loaded into the missile before launch. Most importantly, the KEPD 350E will navigate to its target even if one or two of the navigation systems are jammed or made unavailable. The missile is not dependent on GPS, for example, and is capable of accurately adjusting its route-to-target depending on what navigation and target data is available on a specific mission. In this way, a single KEPD 350E can accomplish a mission that would require three to four missiles of another type.

Courtesy: Taurus Systems GmbH

"IAI set to establish multiple Joint Ventures in India"

VAYU Interview with

Eli Elfassi, VP Marketing, IAI

"IAI plans to establish more JVs in India to support the increased business anticipated in the Indian market, expected to yield several billion dollars in revenues over the next few years."

Having three decades of operations in India, Israel Aerospace Industries (IAI) has gained the reputation of a dominant player in the local defence and aerospace market, highly appreciated by partners, customers and even competitors. With sales of large-scale projects that are currently operational with all military branches and several government agencies throughout the subcontinent. IAI's operational equipment includes unmanned systems, intelligence, surveillance, and reconnaissance assets, airborne early warning, and other, highly advanced sensors and weapon systems, some developed specially to address local requirements.

"We look at India as one of the most dominant markets for IAI," Eli Elfassi, VP Marketing of IAI told *Vayu*. "A significant per cent of our export is attributed to our Indian operations and, our goal is to continue and establish this dominant position in the future, despite the growing competition. The excellent reputation won by IAI and the gains by its Indian customers are instrumental for continued success."

VAYU: What is your strategy regarding the Americans entering the Indian market?

Elfassi: "Yes, we are facing growing competition from Europe and the USA, particularly the Americans which are becoming a significant and a dominant competitor in the area. We see this competition also in different markets in the world and now too in India. Our products have been in use at India for more than 25 years at different strategic systems. We offer cutting edge technology at an affordable price and we believe that our solutions and services will fully meet India's defence needs.

IAI's Heron

VAYU: What about international tenders that consider a growing share of local involvement?

Elfassi: In international tenders we are very competitive as we can leverage our advantages in technology, cost and local partnership. We already provide significant work share of current programmes, through offset and cooperation with dozens of subcontracting. In certain projects the amount of local work share has been more than 50 per cent.

VAYU: What is your approach toward work share with Indian partners? Have you found suppliers and services for your programmes? This is a necessary obligation under 'Make in India.'

Elfassi: We find here all the necessary technologies, there is a mature infrastructure, suppliers have the will and technical and quality levels to enter development and production of advanced systems, and we will transfer more orders with time. To make the most of the new 'Make in India' policy, IAI is planning to expand its operations here. We plan to go beyond the JVs we already have and expand our partnerships to JVs established on a divisional basis, with different Indian partners. This will enable us to better compete on specific opportunities and broaden the cooperation within our Indian JVs."

VAYU: Cyber is another field of activity where IAI is well positioned among global firms. What are you offering for the Indian market?


The BirdEye650D

redesign and re-manufacturing of aircraft at such extensive scale.

The Indian market is big business for IAI. The company currently has dozens of on-going programmes in India, worth over a billion dollars. These include support for systems that are already in use, including sales and services provided over the life cycle of those projects that render dependable, reliable and proven systems through decades of operational use.

We are looking at a deal-flow of dozens of new orders per year from India. Over the coming years these new orders could be worth several billion dollars, and this could even double once more opportunities materialise over the next 5-7 years.

Elfassi: I cannot elaborate on specific offers, but I can say that such operations are often supported by joint ventured established with local companies designed to establish IAI's footprint in this rapidly evolving market. Our strategic activities are designed to support the national level as well as the commercial sector, with solutions designed to protect and improve the resilience and rapid recovery of organisations critical to the national security and economy. To promote these unique and proven solutions IAI often establishes JVs with local partners, from the government, academy and the business sector."

VAYU : Aircraft conversion is another unique IAI capability – do you see prospects here for such services?

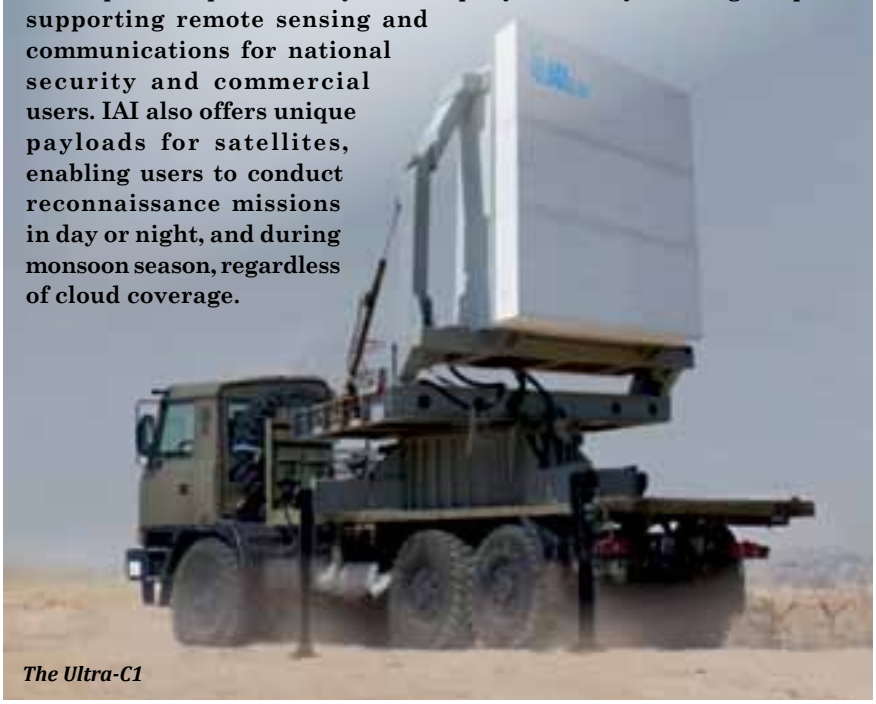
Elfassi: Although IAI does not produce the actual platforms, we have proved our capability to design, integrate and certify such platforms that are modified into special mission aircraft. To meet this goal we converted numerous aircraft – Boeing 767, Ilyushin Il-76, Gulfstream 550, Bombardier Global 6000 and others – providing the best, most optimised platforms to the client. These processes were proven in many projects where transport planes were converted by our experts into aerial tankers or airborne early warning platforms, and several types of business jets were also converted into special mission aircraft. In all these projects the majority of the systems used were developed and produced by IAI. Each of these categories is represented here in India. This is a unique capability only IAI can provide : IAI has mastered the entire range of relevant activities, including design, engineering, manufacturing, testing, certification and through life support. Apart from the Original Equipment Manufacturer (OEM) of the aircraft, IAI is uniquely positioned to provide

IAI : the Multi-Disciplinary Technology Powerhouse

Positioned among global leaders in integrated air and missile defence for land based and naval applications, IAI has a varied portfolio of systems from the Barak and Arrow families, through early warning multi-mission radars, and command, control and battle management systems. Based on the building blocks developed for these systems IAI is extending the families with more models, tailored to address specific customer requirements.

In the field of unmanned systems, IAI offers the entire range of drones, from the largest Medium Altitude Long Endurance (MALE) Heron TP and Heron 1, to small and medium tactical UAVs. The latest addition to IAI's offering is the UAV operation centre, providing operators at territorial command or national level with the ability to manage, control and support a large force of drones.

Satellites are another area of leadership for IAI, and satellites developed and produced by the company are today orbiting in space supporting remote sensing and communications for national security and commercial users. IAI also offers unique payloads for satellites, enabling users to conduct reconnaissance missions in day or night, and during monsoon season, regardless of cloud coverage.


The Ultra-C1

The Rotem multi-rotor loitering munition (photo: IAI)

Israel Aerospace Industries presents a variety of systems at Aero India 2017

"In the past year, Israel Aerospace Industries (IAI) has recorded hundreds of millions of dollars of sales in the Indian market, and the company is expecting to expand local collaboration in many areas to integrate strategic state-of-the-art systems in a number of areas in accordance with the Indian Government's 'Make in India' policy. IAI is participating in Aero India 2017, to build upon some $500 million of business conducted in India during the calendar year 2016."

IAI has been working with the Indian defence industries and armed forces for the past 25 years, as part of strategic collaboration in many fields. Joint development projects include the Barak 8 air defence system, in both its maritime (LR-SAM) and land-based (MR-SAM) versions; special mission aircraft; various radar systems; and UAVs. Collaboration agreements are based on transfer of technology for the benefit of local production as part of the 'Make in India' initiative.

As Joseph Weiss, IAI's President and CEO stated: "India is one of IAI's leading markets. This important market is characterised by long-term collaboration, joint development and production, technology transfer, and technical support over many years. We are working to continue to maintain this status in the future, despite growing competition. The excellent reputation that IAI has earned among its Indian customers is vitally important to continuing this tradition of successful cooperation."

IAI President and CEO Joseph Weiss

IAI is displaying a wide variety of systems at Aero India, with an emphasis on MR-SAM/LR-SAM, loitering munitions such as the low-cost Green Dragon, Harpy NG, Harop, and the Rotem multi-rotor loitering munition – the latter being displayed for the first time in India. Moreover, a range of UAVs are also on display, including the Heron family and the Bird Eye Small Tactical UAS, which enable a wide variety of intelligence gathering capabilities in various spheres of activity. IAI is also exhibiting strategic radar systems, satellite communication systems, and high definition electro-optical systems (M19HD, MOSP 3000HD and Mini-POP). In addition, IAI is showcasing a number of special mission aircraft for intelligence missions, aerial control and naval surveillance on different platforms, such as the EL/W-2090 AEW&C system, and the B767-MMTT tanker/transport. IAI is also highlighting its advanced cyber capabilities at Yelahanka.

"Sharp Eyes in the Sky"

Raytheon's Multi-spectral Targeting System (MTS) on a US Navy helicopter

EO/IR Airborne payloads update

Intelligence, surveillance and reconnaissance (ISR) missions are the essence of modern military tactics. During these missions, electro-optical and infra-red (EO/IR) systems are critical for collecting data, leading to global investment in the sector. Strategic Defence Intelligence's (SDI) latest report expects the global EO/IR systems market to value US$9.1 billion – a figure forecast to reach US$14.3 billion in 2025. EO/IR systems gather high-resolution electro-optic (EO) data during daylight and infrared (IR) imagery during the night. Globally, the need for advanced situational awareness and information dissemination is rising, making EO/IR systems a highly sought-after capability. Many countries are investing in the development and procurement of several EO/IR based aircraft, naval vessels, ground vehicles and UAV payload systems. "Operations in Iraq and Afghanistan have shown that accurate information about enemy formations and other associated intelligence is very important during precision strike missions. EO/IR systems have helped to save the lives of many soldiers, while simultaneously enabling allied forces to overpower the enemy," says Mainak Kar, analyst at SDI.

Most ISR activities in a conflict zone are performed both by unmanned aerial vehicles (UAVs) and manned aircraft. This has created a worldwide demand for airborne EO/IR systems. Aircraft now incorporate a number of EO/IR systems such as targeting and navigation pods, or infrared search and track (IRST) systems. "The arrival of UAVs has provided substantial impetus to the EO/IR market, as these unmanned vehicles are highly endurable and are thus capable of carrying more weight during take-off," says Kar. According to SDI, technological innovations are also responsible for the widespread incorporation of EO/IR systems. New versions of EO/IR systems provide higher-resolution images, while simultaneously reducing size and power consumption so that more cameras can be used on platforms that are less expensive. "This is also one of the major reasons why EO/IR systems – once only available to elite Special Forces – are now prevalent in regular army units," adds Kar.

In another forecast, the military electro-optics/infrared systems market was estimated to be USD 10.15 billion in 2016 and is projected to reach USD 14.20 billion by 2022, at a CAGR of 5.75% from 2016 to 2022. The objectives of this study were to analyse the military electro-optics/infrared systems market, along with statistics from 2016 to 2022 as well as to define, describe, and forecast the military electro-optics/infrared systems market on the basis of platform, system, technology, sensor technology, imaging technology, and region.

The military electro-optics/infrared systems ecosystem includes electro-optics equipment providers such as Lockheed Martin Corporation (US), Northrop Grumman Corporation (US), BAE Systems Plc. (UK), The Raytheon Company (US), and Thales Group (France), among others. Component manufacturers in this market include L-3 Communications Holdings, Inc. (US), Saab AB (Sweden), Rockwell

A Rafael Litening pod mounted on the Saab Gripen

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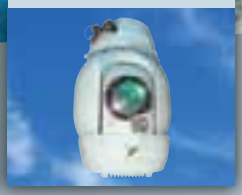

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Controp's SHAPO-Air electro-optical sensor

Collins, Inc. (US), Rheinmetall AG (Germany), Textron Inc. (US), and Israel Aerospace Industries (Israel) and many other smaller Israeli companies among others. These companies offer advanced technology systems and a broad range of management, engineering, technical, electro-optics, sensors, and information services.

The need for advanced situational awareness and information dissemination abilities is driving the development and procurement of several EO/IR based aircraft, rotorcraft and UAV payload systems. The industry participants are significantly investing in R&D in order to emerge with innovations in ground based, air based and naval segments. Various MoDs are procuring a range of new sighting devices for their weapons as well as wearable night vision and thermal imaging systems for their future soldier programmes. Governments worldwide recognise the need to increase agility of military attacks while shortening the time taken to complete a mission. This is where EO/IR Systems are increasing in importance, with their ability to reduce the ISR mission-cycle time and help towards the rapid, ad hoc integration of platforms into strike forces and fast-reaction mission planning.

Miniaturisation is one of the biggest challenges faced by the sector in recent times. It is also expected that it will scale up further during the next decade. EO/IR sensors are becoming standard fitment across several military platforms especially in an air force. The military's round the world are focusing heavily on decreasing the size of aircraft which is putting enormous pressure on manufacturers as they have to compromise on performance in order to reduce size and weight of devices especially the sensors.

Raytheon's Multi-Spectral Targeting System (MTS) provides EO/IR, laser designation, and laser illumination capabilities integrated in a single sensor package.Combat proven, with nearly three million operational flight hours, MTS sensors provide detailed intelligence data from the visual and IR spectrum in support of United States military, civilian and allied missions around the world.Leveraging cutting edge digital architecture, this advanced EO/IR system provides long-range surveillance, target acquisition, tracking, range finding and laser designation for the Griffin and Paveway missiles as well as tri-service and NATO laser-guided munitions. MTS sensors feature multiple fields of view, electronic zoom and multimode video tracking and were designed to incorporate future growth options and performance enhancements.

To date, Raytheon has delivered numerous MTS sensors to United States and international armed forces and successfully integrated variants of the system on rotary-wing, unmanned aerial systems and fixed-wing platforms, including the MH-60 Blackhawk, the C-130 Hercules, the MQ-9C Reaper, the MQ-1 Predator, and the MQ-1C Grey Eagle.

Russia's 'fifth-generation' optronic systems capable of detecting stealth platforms derive much from Russia's space programmes and include built-in targeting and sighting suite OLS-UEM and a conformal optro-electronic pod OLS-K for navigation, reconnaissance and targeting in all weathers to enhance strike capabilities. In air-to-air missions even non-afterburning targets may get detected at more than 45 km, followed by positive identification at 8 to10 km. In air-to-ground (or sea) mode, tanks risk detection at 15 km (positive identification at 8 to10 km) while an aircraft carrier at 60 to 80 km (positive identification at 40 to 60 km). The OLS-UEM (*Optiko-Lokatsionnaya Stantsiya*/optical locator station) Imaging Infrared Search & Track (IIRST) device detects and tracks air and surface targets, as well as showing the pilot an image of the target for identification purposes. Airborne targets can be detected at distances up to 45 km in the tail-on position or 15 km in the head-on position. The integrated laser rangefinder operates at two wavelengths: Eye-safe 1.57 microns for training and 1.06 microns for combat determining the distance to the target from 200 m to 20 km. OLS-K (*Konteynernaya*/ podded), is used for detection and tracking of surface targets. The laser can measure distances up to 20 km. The optical channel, which is shared by the IIR sensor and the TV camera, is installed under a transparent dome similar to the dome of the OLS-UEM unit. The device also includes a laser rangefinder/target designator and laser spot tracker.

The Israeli Rafael Advanced Defense System Litening G4 targeting pod, also to be operated by the Indian Air Force, is an excellent system with a full one mega pixel (1000×1000) Forward Looking Infra-Red (FLIR) in addition to the mega pixel size Charge-Coupled Device (CCD) sensors

A Schiebel Camcopter S-100 with IAI Tamam POP 300 payload

and optics already introduced in the earlier Litening AT version, offering wider field of view and enhanced zoom to deliver more accurate target identification and location at longer ranges than previous generations of the Litening. Another new feature is the Laser Target Imaging Programme (LTIP), employing a Short-Wave Infra-Red (SWIR) laser augmented imaging, to enhance the targeting system's capability to capture images in situations where Medium-Wave Infra-Red (MWIR), FLIR and CCD are ineffective. In addition, the Litening G4 employs an integral digital two-way data link, facilitating encrypted data communications with compatible land-based or airborne digital data link devices.

The Litening G4 will facilitate employment of a broad spectrum of Israeli and United States-origin Precision Guided Munitions (PGM) effective even in high altitude and urban environment with minimum collateral damage. Day, night and adverse weather capabilities are facilitated by the dual Charged Coupled Device/Imaging Infra-Red (CCD/IIR) seeker, the Automatic Target Acquisition (ATA) capability is implemented by a unique scene-matching technology that is robust to scenery changes, countermeasures, navigation errors and Target Location Errors (TLE).

SHAPO, a product of CONTROP Precision Technologies Ltd. is a unique ultra-lightweight gyro-stabilised EO/IR Day/Night Observation system especially designed for flexible EO payload deployment on multi-mission patrol vehicles. The high performance low weight system delivers the benefits of a built-in thermal imaging camera with a continuous zoom lens, advanced image enhancement, automatic target tracker, picture-in-picture and more, all offered in one compact integrated package.

"That SHAPO has been chosen by a leading NATO army is a validation of the system's superior performance," said Mr. Johnny Carni, CONTROP's VP Marketing. "SHAPO won this highly competitive tender thanks to our in-house developed technologies that deliver outstanding operational capabilities relative to its low cost. The system maintains low SWaP (Size, Weight and Power) and superb gyro-stabilisation, which are crucial factors when dealing with patrol vehicles on rough terrain since the vehicles are typically overloaded with various sensors and other

IAI Tamam's MiniPOP EO sensor

systems. These features make the SHAPO payload the most cost effective option when compared to other similar systems on the market".

IAI Tamam's Plug-in Optronic Payload (POP) is a modular, compact, competitively priced gyro stabilised day / night observation, surveillance and targeting system based on a unique plug-in "slice" concept.The payload is able to host different slices containing a variety of sensor combinations such as Focal Plane Array (FPA) Infra-Red/Thermal Imager (IR), colour Charged Coupled Device (CCD), Laser Pointer, eye safe Laser Rangefinder and Laser Designator. The "slice" can be easily replaced in the field within minutes, without the need for alignment or adjustment. The slice concept also allows for easy upgrades whenever new sensor slices are introduced. POP300D-HD High Definition ('Designator') is a single LRU stabilised payload, based on this unique plug-in optronic 'slice' that can be replaced in the field in minutes. The payload is equipped with powerful high definition IR sensor, high definition continuous zoom colour day TV, dual wavelength Laser Designator & Range Finder (eye safe) and Laser Pointer as an option. The payload's Line-of-Sight (LoS) control can be selected as manual selection, auto- track, slave and scanning.

Automatic video tracker for both the thermal and the CCD channels is a standard option on all POP models. The system's electronics is contained within the turret thus allowing for easy installation and maintenance.POP is ideal for tactical Unmanned Aerial Vehicles (UAV), helicopters, fixed wing aircraft, land vehicles and light boats. Over 1400 POPs have been delivered to defence forces and security agencies worldwide.

MiniPOP is an 8" lightweight payload for day/night observation system designed for military, para-military and civilian applications. The payload provides real-time image, automatic video tracker capabilities and precise target geo-location for small platforms including small UAVs, armoured vehicles, Unmanned Ground Vehicles (UGVs) and naval vessels.MiniPOP is a dual axis, gyro-stabilised payload. The payload is one Line Replaceable Unit (LRU), open architecture design that carries up to four sensors. The basic configuration includes a continuous zoom colour day camera and a thermal imaging camera. A laser pointer, eye-safe laser range finder and automatic television tracker can be incorporated for greater capabilities and functionality. MiniPOP is remotely controlled through RS422 serial communication or by a Hand Control Unit (HCU) (option).

The Multi-mission Optronic Stabilised Payload (MOSP) family is a multi-sensor highly stabilised payload for different applications, such as MOSP for UAVs applications (Day and/or Night and/or LRF), HMOSP for helicopters and fixed-wing aircraft applications (Day and/or Night and/or Laser Designator/Range Finder), and SeaMOSP that is same as HMOSP but for maritime applications. More than 400 MOSP family systems are in operational use by different armies around the world.MOSP 3000 encompasses the latest technologies on gimbal and sensor design such as single LRU concept, lower weight, improved stabilisation, advanced imageprocessing and state-of-the-art digital format sensors.

Finally, the LOROS is a multi-sensor imaging system for long-range day and night observation maximising IAI/Tamam's expertise of high level stabilisation and navigation technologies. The system includes highly gyro-stabilised turret with 4 sensors (Thermal imager, colour CCD zoom, B/W CCD spotter and ICCD) and laser range finder (LRF). In conjunction with airborne workstation and mobile ground station, LOROS is used for Intelligence, Surveillance and Reconnaissance (ISR) missions. The system features automatic target tracker, enhanced image processing and long range down-link of video and data.

Sayan Majumdar, with extra inputs from the editorial team

Airbus at Aero India 2017: focus on 'Make in India' partnerships

Airbus' industrial partnerships with Indian companies under the 'Make in India' initiative is the tone of its participation at the 11th edition of Aero India. "The future of Indian aerospace and defence industry rests on the realisation of the 'Make in India' vision. I look forward to having conversations around the topic at Aero India," stated Pierre de Bausset, President and Managing Director, Airbus India. "We have partnered with Tata and Mahindra and are working with a host of other companies to script 'Make in India' success stories," he added.

Visitors at the Airbus stand will get a first-hand account of Airbus' industrial engagement with India which yields over US$500 million (approx. Rs3,400 crores) in procurement from India annually from around 45 suppliers, generating local employment for more than 6,000 people. To illustrate the scale of co-operation, Airbus can proudly claim that each of its commercial aircraft produced today is partly 'Made-in-India'.

The potential of Airbus and India partnership is bigger and this is being exhibited in the form of scale models of the C295W military transport aircraft and the AS565 MBe Panther helicopter.

As part of the Avro replacement programme of the Ministry of Defence, Airbus will support Tata Advanced Systems Limited (TASL) in setting-up a final assembly line for the C295W in India, once the contract is awarded. Airbus has tied-up with Mahindra Defence to create India's first private sector entity for manufacturing military helicopters. Making India the global hub for 'Panther' manufacturing – producing Panthers in India, for the domestic market as well as for exports – is proposed under the Naval Utility Helicopter programme.

The scale model display line-up includes the EC725, now marketed as the H225M, which is under negotiation for the Indian Coast Guard's requirement for 14 shore-based helicopters as well as the fuel efficient A320neo commercial aircraft. There are around 590 A320neo on order from India which means, on average, one aircraft will be delivered to India per week over the next 10 years.

C295W

Aviators Air Rescue, in partnership with the Air Medical Group Holding Inc. (a leading air medical provider in the United States), became the first Indian operator to induct three Airbus H130 helicopters in a dedicated air ambulance role last year. One of these helicopters, fully kitted out with specialised emergency medical care equipment, will demonstrate its life-saving service throughout the business days of the show.


AS565 MBePanther

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Indo-Japan Defence Co-operation

Acquisition of the US-2: slow but steady progress

The case for acquisition of amphibious aircraft for the Indian Navy began way back in 2011 when the Navy issued a Request for Information (RFI). Japan's ShinMaywa Industries Ltd, responded to the RFI and paved the way for commencing a new chapter of co-operation between India and Japan in the defence sector. The unique capabilities of the US-2 amphibian had clearly made it an interesting consideration for acquisition. As the IN progressed the acquisition case of amphibious aircraft on operational merit, possibility of procurement of US-2 by India was discussed during an Annual Summit Meeting between Prime Ministers Manmohan Singh and Shinzo Abe, held in May 2013 at Tokyo. Directives were issued in the Joint Statement between the two Prime Ministers towards formation of a Joint Working Group (JWG) to explore modalities for co-operation on the US-2 procurement. The Joint Working Group completed its deliberations in 2013 and provided its inputs to the MoD towards possible merits of such acquisition. The Navy was independently progressing their case for requirement of amphibious aircraft within the established regulations of the Defence Procurement Procedure as per the Service's long term operational requirement.

Over the last few years, an acquisition case for the US-2 has seen its own (typical) issues. Progress has been serpentine at the best. Amidst constant media speculations, both governments have been cautious in progressing their discussion in the case. In case the acquisition case does fructify, it would be the first military procurement co-operation between India and Japan. For Japan, this would be first sale of its military hardware to any developing country. However, since the procurement is unique in nature and the process of acquisition through the G-to-G route itself is being attempted for the first time between India and Japan, the pace has been understandably slow and deliberate. In addition, since the Indian Navy is set to acquire such capability after a long time, the acquisition case is being subjected to detailed deliberations at every stage. The multi-role capabilities of the aircraft are unique and presumably meet all the operational requirements of an amphibious aircraft as envisaged by the Indian Navy.

However, this aircraft comes with a big price tag. It is understood that cost related issues have been a matter of concern for the Government of India at every stage. It is however also understood that the Government of Japan has been assuring India of a 'fair consideration' on all issues related to the project including pricing, and the Japanese government has been regularly deputing top-level functionaries to India for discussions with their respective counterparts at various levels. Visit of Mr Tetsuro Kuroe, Administrative Vice-Minister of Defence to India on 2-3 November 2016 to meet and discuss issues related to the US-2 project with Mr Manohar Parrikar and the Defence Secretary, which was prior to the recently concluded Summit Meeting indicates the Japanese intent. The acquisition case has found regular mention in '2+2' dialogues between the two Defence and Foreign Secretaries and in Joint Statements released during annual Summit Meetings between the two Prime Ministers. It is understood

that Japan intends progressing this case under strategic defence co-operation between the two nations. The Acquisition, Technology and Logistics Agency (ATLA) of Japan under their MOD, has been nominated to be the nodal agency to coordinate all aspects of the US-2 project.

This acquisition case was considered by the DAC conducted in November 2016 (*see Vayu VI/2016*), however no decision could be taken. It is now understood that the government of India is analysing the exact role requirements that the Indian Navy aims to achieve with such capability and a 'cost-benefit analysis' of such an acquisition and it is assumed that next level of G-to-G discussions would commence thereafter.

Defence co-operation between India and Japan till now has been limited to inter-services Joint Exercises (*Malabar, JIMEX*, etc), and participation in seminars and each other's training courses. However, recent years have shown increased bonhomie between the two nations on matters related to maritime security, terrorism, threat perception in the Indian Ocean Region and South China Sea and defence co-operation. Successful passage of the landmark civil nuclear deal between the two nation and Japan's constant support for India's entry into the elite NSG stands testimony to the ever increasing partnering in strategic areas by the two nations. Extending this to defence acquisition between the two nations progresses this cooperation to the next level. That, by the way, is also in alignment to the increased impetus of the Indian Government towards its own 'Look East' policy.

In addition to meeting military roles and requirements as envisaged by the Indian Navy, the unique capabilities of the US-2 also allows for providing credible assistance during natural calamities and disasters to friendly countries of the Indian Ocean Region. This is in sync with India's aspiration to be a formidable maritime power and influence operations in the IOR as a regional power. With ever increasing Chinese influence in the Indian Ocean Region and South China Sea and China's own AG 600 amphibious aircraft programme on 'short finals', positive cooperation between Japan and India in this project seems like a good idea.

Since the Indian Navy envisages procurement of six such platforms, it may be overly optimistic to believe that these aircraft would be manufactured or assembled in India. However, the US-2 programme could surely enable transfer of some high-end Japanese aircraft manufacturing and maintenance technology to India through parts manufacturing and MRO activities and thereby promote 'capability and capacity building' of the Indian aviation industry in the private sector through an appropriate offset obligation implementation plan.

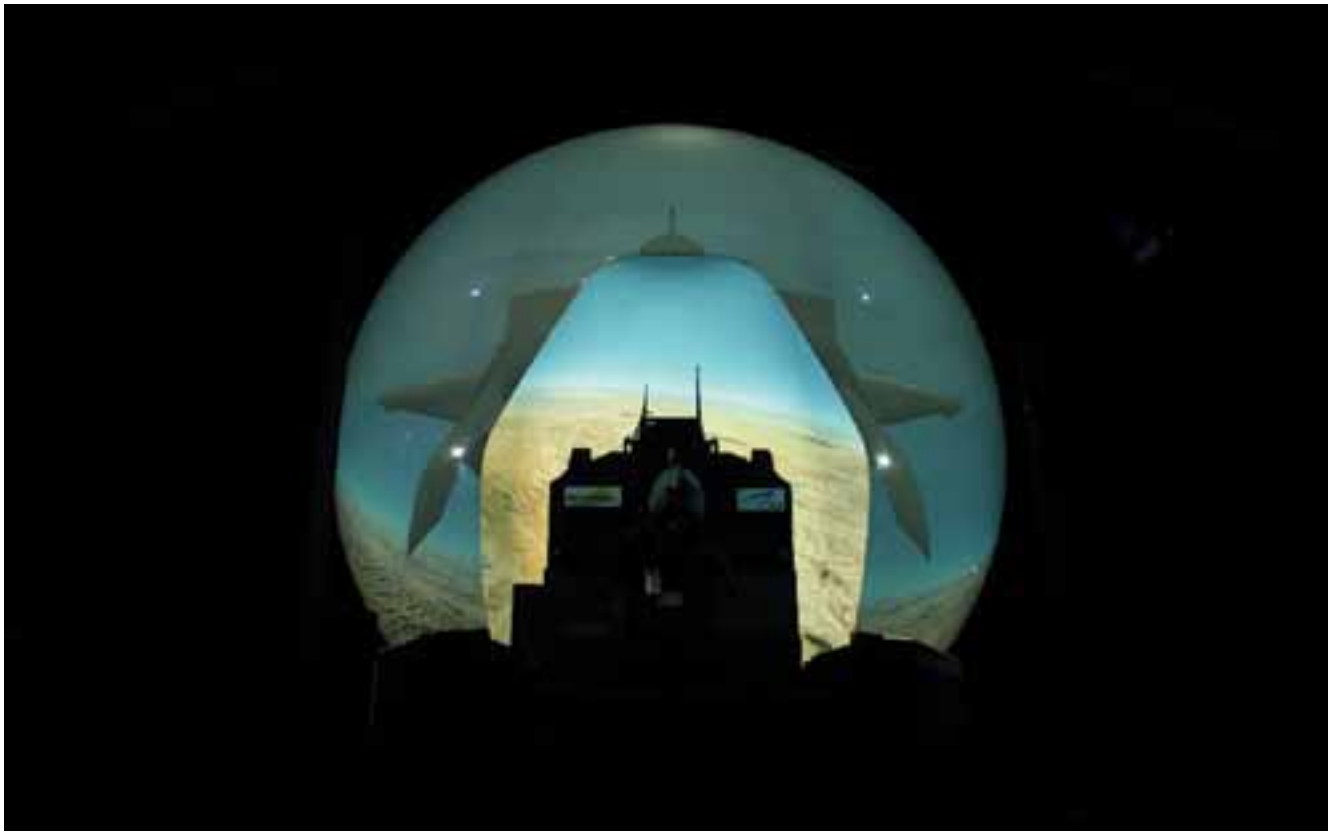
Update on Elbit Systems

US Army orders Elbit ID/IQ mortar weapon systems

Elbit Systems US subsidiary, Elbit Systems of America has been awarded an Indefinite Delivery/Indefinite Quantity ("ID/IQ") contract for the production of mortar weapon systems. The contract, with a value of up to approximately $103 million, will be performed over a five-year period. "We are extremely pleased to continue our partnership with the United States Army by supplying our warfighters with the mortar weapon systems that enhance their mission effectiveness and provide the necessary precision and flexibility to address current and future threats," commented Raanan Horowitz, president and chief executive officer of Elbit Systems of America.

Elbit M-346 Ground Based Training System Centre

Elbit Systems has completed delivery of the Ground Based Training System (GBTS) centre for the M-346 Lavi trainer aircraft. This comprehensive training solution was selected by the Israeli Air Force and the Directorate of Production and Procurement, "to effectively and affordably qualify its pilots and Weapon Systems Operators (WSOs) to progress directly to fourth and fifth generation fighter aircraft" (F-16, F-15 and F-35). Based on cutting-edge simulation technology and training capabilities, the GBTS enables flight academy cadets, as well as graduate pilots and WSOs, to practice unusual and in-flight emergency procedures, and at a more advanced level, to simulate complex combat scenarios, acting as a solo pilot or as part of a formation. Embedded Tactical Training System (ETTS), Elbit's technology live training system, provides live training within the GBTS as well as in the real aircraft.



Elbit to supply Remote Controlled Weapon Stations

Elbit Systems' Brazilian subsidiary, *Ares Aeroespacial e Defesa S.A.* ('Ares'), has been awarded a framework contract of approximately $100 million, to supply 12.7/7.62 mm Remote Controlled Weapon Stations (RCWS) to the Brazilian Army *(picture above)*. The contract includes associated equipment and services. The RCWS, named REMAX, will be supplied over a five-year period. An initial production order, valued at approximately $7.5 million, has been received. Specifically designed by Ares to meet Brazilian Army requirements as part of the VBTP programme, Ares' REMAX systems have been successfully tested and fielded in Brazilian Army Guarani 6X6 vehicles. REMAX is a stabilised weapon station for 12.7/7.62 mm machine guns and will be used in armoured vehicles and logistics vehicles utilised in combat for troop transport, border patrol and peace keeping missions.

ClearVision on the Falcon8X

Elbit's ClearVision EFVS

The Elbit Systems ClearVision Enhanced Flight Vision System (EFVS) is aligned with the most updated ruling released by the US Federal Aviation Administration (FAA), enabling the pilot to perform a complete landing procedure with no 'natural vision.' The EFVS was designed with a futuristic approach, consistent with the recently updated FAA ruling. The system offers 'unmatched' capabilities, providing dispatch and landing approach priority as well as Low Visibility Landing regardless of the destination airport's infrastructure.

Unmanned Sentinels

UAVs in India

The Indian Army was the first service to acquire Unmanned Aerial Vehicles (UAV) in form of Israel Aerospace Industries (IAI) Searcher Mark I, followed by the Searcher Mark II and finally the Heron Medium Altitude Long Endurance (MALE) UAV. The Searcher Mark II is being successfully used in the mountains as also in the plains and semi-deserts. The Indian Air Force quickly built up a similar inventory, while the Indian Navy (IN) acquired the Searcher Mark II and Heron for long range maritime surveillance missions, operating them from Kochi and Porbandar.

Backbone of the fleet is the fourth generation GPS-enabled Heron / Machatz 1 MALE UAV, designed and manufactured by Israel Aerospace Industries (IAI) at its Malat division, in partnership with the Canadian company MacDonald, Dettwiler& Associates (MDA). Heron entered operational service with the Indian Air Force in high-altitude land surveillance near mountainous borders, and in IN service for maritime patrol missions. Heron has proved to be capable of fully automated take-off and landing, even under adverse weather conditions. Flying at a height of 30,000ft, the UAV provides operators with real-time information on enemy battlefields/ activities by performing Information, Surveillance, Target Acquisition and Reconnaissance (ISTAR) activities over wide areas in support of national agencies, theatre commanders and lower echelons using multiple sensors and Satellite Communications (SATCOM) for extended-range capture and transfer of critical data.

Searcher Mk.II in flight

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The UAV is also capable of providing reliable Battle Damage Assessment (BDA). IAI is set to supply around 60 Heron MALE UAV to the various branches of the Indian Armed Forces, now also including the Heron TP/Eitan Unmanned CombatAerial Vehicle (UCAV).

Powered by a single 85.79kW Rotax 914 turbo aircraft engine manufactured by Austria›s BRP-Rotax,the Heron can climb at the rate of 150m a minute and fly at a maximum speed of 207km/h to a range of 350km (Satellite Communications enables this range to be extended to beyond 1,000km) and has demonstrated 52 hours of continuous flight with modular space up to 250kg for customer-furnished equipment that may include Electro-Optical (EO) and Infra-Red (IR) sensors (supplied by Northrop Grumman and Tamam Division of IAI), thermal surveillance equipment and laser designator. While the EO sensor converts light rays into electronic signals for capturing images, real-time data and videos, the laser designator is applied for targeting the enemy on battlefield. Thermal surveillance equipment is used to capture high resolution images during night by penetrating through clouds, rain, smoke, fog and smog. Communications are established through direct Line-of-Sight (LoS) data-link, UAV airborne data relay for beyond LoS missions and ground-based data relay for communicating with the Ground Control Station (GCS). Additionally, Electronic Support Measures (ESM) helps the Heron in threat detection and examines the area to determine signals emitted from the surrounding radars.

For maritime roles, an Automatic Identification System (AIS) capability gathers details of ships such as vessel type, vessel name and destination. The Elta Maritime Patrol Radar (MPR) identifies vessels from very long distances by applying silhouette target acquisition procedures. MPR also provides Synthetic Aperture Radar (SAR) images and near coastline detects ground vehicles using its Ground Moving Target Indicator (GMTI) mode.

The Heron can be controlled either manually from the GCS or operate in autonomous mode. As mentioned earlier, it is fully equipped with an automatic launch and recovery (ALR) system, which helps in automatic safe landing in case of communication failure with the GCS. The processing, retrieving and storing of the real-time data provided by Heron UAV is undertaken by the GCS to convert the sensor data such as live and stored images, imagery and spatial information, including EO, SAR, MTI maps, SIGINT and ESM, into actionable intelligence.

An enhanced variant of Heron, the Heron TP/Heron 2/Eitan, developed under an Israel Ministry Of Defence (IMOD) programme, can carry multiple payloads and perform multiple missions such as Communication Intelligence (COMINT), Signal Intelligence (SIGINT) and Image Intelligence (IMINT). These have entered service with the Israeli Defence Forces (IDF), and are cleared for export to India. Heron TP can fly at 45,000 ft with endurance of approximately 36 hours. Apart from long range, long endurance ISTAR missions, Eitan is designed to execute a large variety of operational missions, including aerial refuelling and strategic missile defence. Eitan made its maiden flight on 15 July 2006, the new UAV providing the Israel Air Force persistent, High Altitude, Long Endurance (HALE) ISR capability well beyond the reach of enemy air defences and far beyond Israeli borders. Heron TP is powered by a single 1,200hp Pratt & Whitney Canada PT6A turboprop engine driving a four-blade propeller. The use of such a powerful engine enables the aircraft to climb and operate at altitudes above 40,000ft, avoiding airspace conflicts with commercial aircraft traffic. Using on board

Heron TP on take off

fuel and power resources, Heron TP is able to sustain continuous missions for over 36 hours with full mission payload and is also equipped with de-icing systems protecting the aircraft when flying through icing conditions.

With maximum takeoff weight of 4,650 kg, Eitan can carry over 1,000kg of sensors in its forward section, main payload bay, and the two bulges located at the end of each tail boom, offering optimal separation for specific systems. Other stores can be mounted along the wing, in internal and external positions. Eitan could be fitted with wing hard-points for external stores. The aircraft is equipped with multiple data-links, supporting LoS and Beyond Line-of-Sight (BLoS) links via satellite communications. The giant drone maintains the twin tail boom principle offering stable and redundant design and large payload bay located around the aircraft centre of gravity, uninterrupted by the landing gear. This configuration allows for quick and simple payload reconfiguration on the flight line.

While the indigenous Rustom-II is being developed to serve as a MALE UAV, media reports indicate that India has officially discussed possible procurement of the MQ-9 Reaper (Predator B) and jet-powered Avenger (Predator C) with manufacturer General Atomics and the US Government.

Designated MQ-9 Reaper by the USAF and Protector by the Royal Air Force, the turboprop-powered, multi-mission Predator B Remotely Piloted Aircraft (RPA) was developed with General Atomics Aeronautical Systems Inc (GA-ASI) funding and provides significantly greater capabilities than Predator. First flown in 2001, Predator B is a highly sophisticated development built on the experience gained with the company's battle-proven Predator RPA and is a major evolutionary leap forward in overall performance and reliability.

Featuring unmatched operational flexibility, Predator B has an endurance of over 27 hours, speeds of 240 KTAS, can operate up to 50,000 ft, and has a 3,850 lb (1746kg) payload capacity that includes 3,000 lb (1361 kg) of external stores. Nearly twice as fast as Predator, the aircraft carries 500 percent more payload and has nine times the power, providing a long-endurance, persistent surveillance/strike capability. An extremely reliable aircraft, Predator B is equipped with a fault-tolerant Flight Control System (FCS) and triple redundant avionics system architecture engineered to meet and even exceed manned aircraft reliability standards. To enhance engine performance and fuel efficiency, particularly at low altitudes, Predator B is powered by the Honeywell TPE331-10 turboprop engine, integrated with Digital Electronic Engine Control (DEEC). LoS data-link operates in C-Band whereas BLoS data-link operates in Ku-band.

An MQ-1 Predator equipped with Hellfire missiles and an electro-optical sensor turret

The GA-ASI Predator C, distinguished primarily by its turbofan propulsion

The predator B is highly modular and configured easily with a variety of payloads on its seven external stations to meet mission requirements. It is capable of carrying multiple mission payloads to include EO/IR sensors, Lynx Multi-mode Radar (MMR), multi-mode maritime surveillance radar, Electronic Support Measures (ESM), laser designators, and various weapons packages. A new variant, Predator B ER, has been designed with field-retrofit table capabilities such as wing-borne fuel pods and a new reinforced landing gear that extends the aircraft's already impressive endurance from 27 hours to 34 hours, further increasing its operational flexibility. The aircraft will evolve again when its wingspan will grow from 66 feet to 79 feet to hold the fuel that was previously stored in the fuel pods. This configuration will give it 42 hours of endurance.

The next-generation jet-powered Predator C (Avenger) first flew in April 2009. Its unique design featuring a retractable EO/IR gimbal, reduced signature, and higher speed, increases its survivability in higher threat environments and provides potential customers with an expanded quick-response armed reconnaissance capability. The high-speed, multi-mission Avenger is a long-endurance, medium-to-high-altitude RPA system that can perform wide-area surveillance, time-sensitive strike missions over land or sea, and a host of other challenging military missions. The aircraft has much higher operational and transit speeds than current Predator-series aircraft, resulting in quick response and rapid repositioning for improved mission flexibility and survivability.

This tubofan-powered aircraft is equipped with a Pratt and Whitney PW545B engine capable of producing 4,800lb installed thrust. The engine is designed for greater fuel economy and allows the Avenger to operate at speeds up to 400KTAS, a maximum altitude of 50,000ft, and 18 hours endurance. Its significant payload capacity enables it to carry multiple sensors on six external hard points, while its internal weapons bay can house 3,500lb of precision munitions and can be employed in 'swarm' tactics. An extended range variant of Avenger will feature a 76ft wing span and increased fuel capacity that will increase the aircraft's endurance to 20 hours.

On 16 November 2016, India's Aeronautical Development Establishment (ADE)-developed Rustom-II/TAPAS 201 MALE UAV successfully completed its maiden test flight at the Aeronautical Test Range (ATR) in Chitradurga, near Bangalore. The UAV is capable of undertaking ISTAR missions up to a range of 250 km.The 1.8 tonne UAV has a wingspan of 21 m, a capacity payload of 350 kg, an endurance of over 24 hours, and an operational ceiling of 10,660 m (34,776 feet).Payloads are projected to include medium and long-range EO sensors, SAR, ELINT, COMINT, and situational awareness payloads for round-the-clock operations.

The IAF has also acquired the 1,000km range Harop loitering (6hours) Anti-Radar Homing (ARH) UCAV designed to explode on a high value pre-programmed target both on land and sea and is a vital candidate for Suppression of Enemy Air Defences/Destruction of Enemy Air Defences (SEAD/DEAD) missions.

For urban warfare and law enforcement and counter insurgency duties, the IAI Ghost mini-UAV represents an ideal candidate. Resembling a miniature CH-47 Chinook tandem rotor helicopter, this was developed to support missions in urban warfare. The quickly deployable and easily operate able system can be carried in two backpacks that can be quickly assembled, has low acoustic signature propulsion and mission versatility that can perform by day and night. Thanks to automatic vertical take-off and landing, it is suitable for use in densely built-up areas. Its functions can be operated by simple man-machine interface. The main purpose of the Ghost is to undertake ISR missions, including silent observation, stakeout and covert special operations.

Sayan Majumdar

Updates from Lockheed Martin

LM to modernise Republic of Korea F-16s

Lockheed Martin has been awarded a $1.2 billion contract to upgrade 134 F-16 aircraft for the Republic of Korea Air Force (ROKAF), the upgrades based on the advanced F-16V configuration. Among the enhancements are an Active Electronically Scanned Array (AESA) radar, a modern commercial off-the-shelf (COTS)-based avionics subsystem, a large-format, high-resolution centre pedestal display and a high-volume and high-speed data bus. The contract for the ROKAF upgrade is a foreign military sales contract issued by the US Air Force.

T-50A flight operations

The Lockheed Martin T-50A is undergoing test flights over Greenville, South Carolina, the initial test flight taking place on 19 November 2016. The T-50A was announced as the official Lockheed Martin/ Korea Aerospace Industries (KAI) candidate for the USAF's Advanced Pilot Training (APT)/T-X competition in February 2016. Building on the proven heritage of the T-50, the T-50A has more than 100,000 flight hours behind it, training more than 1,800 pilots.

Chilean AF order S-70i Black Hawk helicopters

Sikorsky, a Lockheed Martin company, has successfully concluded contract negotiations with the Chilean Air Force *(Fuerza Aérea de Chile)* for six S-70i Black Hawk helicopters for the service's medium-lift helicopter recapitalisation programme. When delivered in 2018, the new helicopters will fulfill Chile's requirement to perform both military and humanitarian missions, such as troop transport, search and rescue, and disaster relief. The programme includes a logistical support package that will cover spare parts, pilots and maintenance specialists training, on-site technical assistance and ground support equipment.

USAF C-130 flies with Rolls-Royce engine upgrade

The first US Air Force C-130H aircraft to be equipped with the Rolls-Royce T56 Series 3.5 engine upgrade has made its first flight, demonstrating significant improvement in fuel efficiency, lower operating temperatures and improved high-altitude performance. Preliminary flight data showed fuel efficiency improved by approximately 12 percent and turbine temperatures were more than 100°C lower. Reduced turbine temperatures increase parts life and lower operating costs significantly. The Series 3.5 technology, which is based on proven advances from other Rolls-Royce engines, can be added during regular overhauls and requires no changes to the aircraft or controls.

LM in contract for PAC-3 missiles

The United States and Allied military forces will upgrade their missile defence capabilities under a new $1.45 billion contract for production and delivery of Lockheed Martin Patriot Advanced Capability-3 (PAC-3) and PAC-3 Missile Segment Enhancement (PAC-3 MSE) interceptors. The contract includes PAC-3 and PAC-3 MSE missile deliveries for the US Army, and Foreign Military Sales of PAC-3 interceptors, launcher modification kits, associated equipment and spares for Qatar, the Republic of Korea, the Kingdom of Saudi Arabia, Taiwan and the United Arab Emirates. The PAC-3 Missile is a high-velocity interceptor that defends against incoming threats, including tactical ballistic missiles, cruise missiles and aircraft. PAC-3 currently provides missile defence capabilities for six nations: the USA, the Netherlands, Germany, Japan, the United Arab Emirates and Taiwan. Kuwait has also contracted for PAC-3 missiles.

Updates from Raytheon

SM-6 approved for International Sales

The US Department of Defence has approved the release of Raytheon's Standard Missile-6 to several international customers, many of whom seeking the multi-mission SM-6 to bolster their ship-building programmes. SM-6 currently provides US Navy vessels with extended-range protection against fixed- and rotary-wing aircraft, unmanned aerial vehicles, cruise missiles and ballistic missiles in the terminal phase of flight.

SM-6 continues to go further and faster, and has shattered the record for the longest range surface-to-air intercept in September 2016 – a milestone it set, and broke, twice before. In April 2015, Raytheon delivered the first full-rate production SM-6 from its $75-million, 70,000-square-foot SM-6 and Standard Missile-3 all-up-round production facility at Redstone Arsenal in Huntsville, Alabama. Raytheon has currently delivered more than 300 SM-6 missiles with production continuing.

Raytheon Multi-Spectral Targeting System

In January 2016, Raytheon was awarded a $19.24 million firm-fixed-price modification under a previously awarded job order for seven Multi-Spectral Targeting Systems (MTS) in configuration "D" for the Navy. The MTS is an airborne, electro-optic, forward-looking infra-red, turreted sensor package that provides long-range surveillance, high altitude target acquisition, tracking and range-finding. Work will be performed in McKinney, Texas, and is expected to be completed by December 2018. To date, Raytheon has delivered nearly 3,000 MTS sensors to US and international armed forces and successfully integrated 44 variants of the system on more than 20 rotary-wing, unmanned, and fixed-wing platforms, such as the MH-60 Blackhawk, the C-130 Hercules, the MQ-9C Reaper, the MQ-1 Predator, and the MQ-1C Gray Eagle.

Raytheon and US Navy in Tomahawk Blk 4 flight tests

Raytheon and the US Navy have completed two flight tests with the Tomahawk Block IV cruise missile. According to the company, the tests were conducted to demonstrate the missile's ability to engage time-sensitive targets. During the first test, a Tomahawk missile was fired by US Navy personnel from the *Arleigh Burke*-class guided missile destroyer USS *Pinckney,* using the Launch Platform Mission Planning capability. The weapon followed a pre-planned route throughout the trial.

USAF SATCOM contract for Raytheon

In December 2016, the US Air Force awarded Raytheon a $37 million contract to demonstrate new satellite communications technology that will continuously link tactical users with military leaders in contested environments. Managed by the Space and Missile Systems Centre at Los Angeles Air Force Base, the Protected Tactical Services Field Demonstration, or PTSFD, programme represents a major improvement in anti-jam security via the Wideband Global Satellite Communications, or WGS, constellation and commercial satellites. The new, protected SATCOM system is expected to bring a distinct set of capabilities, including flexible access to commercial and government SATCOM channels for seamless transition between SATCOM systems to maximise communications availability for tactical forces. Work will be performed in Marlborough, Massachusetts, and is expected to be completed by 30 September 2020.

VAYU Interview with

Giora Katz, EVP Marketing and Business Development, Rafael

Seen left to right: i-Derby BVRAAM, Python 5 CCM, and SPICE standoff PGM mounted on an Israeli F-16 (photo: Rafael)

VAYU : The Tejas LCA recently commenced BVRAAM testing with the Rafael i-Derby. It is understood that testing with the Python missile is also planned. What is the role and extent of Rafael's participation in the trials and testing process?

GK: The i-Derby is an active radar air-to-air missile that provides fighter aircraft with outstanding and effective performance in both short ranges and Beyond Visual Range (BVR) intercepts. The missile enables operational flexibility and multi-shot capability. It can be launched at an enemy aircraft by day or night and in all weather conditions.

Additional i-Derby capabilities include look-down/shoot-down, sophisticated fire-and-forget mode and an advanced ECCM tailored to the customer's operational requirements. i-Derby's light weight allows it to be adapted to various modern fighter aircraft, including light aircraft, such as the F-5, Mirage and F-16.

For the time being, the i-Derby is the only Rafael system that has been integrated with the Tejas LCA, but we hope for more to follow.

VAYU : The Barak-8 missile for the Indian Navy has cleared all trials and entered service, while the land-based MR-SAM based on the same missile is presently being tested. What part did Rafael play in the development and fielding of this missile and what role, if any will your company have going forward as the system is produced in volume for the Indian market?

GK: Rafael is indeed a sub-contractor in the programme. However, since IAI is the prime contractor, it would be best if they answered your questions on this subject !

VAYU : Rafael was selected to provide Spike ATGMs to the Indian Army in 2015, but the contract has still not been concluded. What are the reasons for the delay and how are they being resolved?

GK: We are very pleased with the selection of the Spike as the next Indian Army missile, and we are moving towards closing the contract. As you know, the Spike missile family consists of precise tactical missiles for ranges between 200-30,000 metres. Spike is a multi-purpose, multi-platform, electro-optic missile system with real time data link, that can be used by infantry units as well as mounted on combat vehicles, attack helicopters and naval vessels. It is combat proven and in service with many countries including Italy, Germany, the Netherlands, Spain, Poland and others. The missiles have sophisticated electro-optic CCD or IIR sensors for day/night all-weather operation, as well as a tandem warhead. Their lofted trajectories enable the warhead to strike the target at its most vulnerable location with pinpoint precision. All Spike family missiles have

Rafael Litening and Reccelite pods on display

low life-cycle costs due to high reliability, operational and logistic support, and production commonality between variants.

***VAYU**: Rafael and Bharat Forge have announced a JV to produce defence electronics and carry out military vehicle upgrades. Will this partnership be limited to the Indian market or will Bharat Forge work with Rafael on global offers and products?*

GK: Rafael has been an active participant in the Indian defence market for several years. We have always endeavoured to contribute to modernisation of the Indian Armed Forces. As part of our global strategy, we form alliances to develop military applications based on our proprietary technologies. With Bharat Forge, we see a lot of synergy and opportunities for growth in new markets, especially in India, which is a strategic market for us.

***VAYU**: Rafael is promoting the new generation Litening 5 in India, citing improved baseline performance and expanded capabilities. What are the key differences between the new Litening and a dedicated ISR pod such as Reccelite? Is there still a market for Reccelite among customers that opt for Litening 5?*

GK: As the need for air superiority continues to play an increasing role in all types of recent military conflicts, the ISR market has experienced simultaneous growth, and has accordingly become very vibrant. With vast experience and expertise in the electro-optical and C4ISR domain, Rafael is addressing these challenges and has developed a new generation of operational lightweight sensors with longer range and higher resolution for manned and unmanned aerial systems (UAVs). Emphasis has been given to compatibility to different platforms and the integration of different sensors into one system. Rafael's most recent developments are RecceLite XR, an extended-range ISR pod and Litening 5, a longer-range navigation and targeting pod. Both Litening 5 and RecceLite XR have the same mechanical and electrical interface properties as the current configurations, and thus can be carried by the same platforms with minimal integration efforts.

RecceLite XR is a multi-spectral, multi-role, real time, stand-off reconnaissance system consisting of an airborne pod, a wide digital data link, and a ground exploitation station. RecceLite XR is based on the RecceLite, which is already in operational use worldwide. It includes higher resolution sensors in both IR and visual wavelengths, and provides significantly wider day and night area coverage, thus enhancing the operational utility in the ISR mission. RecceLite XR uses existing ground infrastructure and data links.

Litening 5 is designed for targeting and designation of targets by day and night. Litening presents pilots with real-time, Forward Looking Infra-Red (FLIR) and TV HD colour camera imagery. The new pod includes higher resolution sensors than current Litening configurations, enabling pilots to identify targets with higher reliability at longer ranges, and consequently avoid collateral damage. It is fully operational 24 hours a day and in adverse weather conditions. Litening 5 includes unique computer vision features designed to reduce pilot workload.

Both RecceLite XR and Litening 5 are based on actual real operational experience and deep understanding of current and future battlefield requirements.

***VAYU**: What are the main focus areas for Rafael at this year's Aero India?*

GK: Rafael has a long legacy of development of cutting-edge technologies, unique in their capabilities and proven to be game-changers in today's complex battlefield. Starting with air defence, Rafael has developed and manufactured Iron Dome, a combat-proven system designed for interception of short-range rockets and mortars. This success has led Rafael to spin its breakthrough technology to be used for protection of naval assets such as ships, rigs, ports, etc., and to this end it has come out with the C-Dome naval air defence system integrated on board ships of different kinds, using the same Iron Dome interceptor, while enabling the use of the ship's existing detection radar. Rafael's SPYDER air defence system is yet another element in Rafael's multi-level air defence concept, using the advanced Python-5 and i-Derby missiles in surface-launched mode for interception at short and medium ranges.

Rafael's portfolio of solutions comes together to ensure quick and effective sensor-to shooter engagement of evasive, real-time threats. At **Aero India 2017**, Rafael will present the unique SPICE family of air-to-ground guided bombs, including the SPICE-250 for precise strikes at ranges up to 100 km, using smart navigation and scene-matching technology, and the Spike family of precise, tactical missiles that can be launched from a variety of platforms to different ranges and missions. Rafael will also present the advanced Litening 5 and Reccelite XR electro-optical pods.

For Rafael, India is a strategic and significant partner. As a global company, we not only present combat proven systems, but can also account for proven partnerships all over the globe. One of our strengths lies in our ability for technology and knowledge transfer, which allows our partners to produce and supply local systems. We have already partnered with Bharat Forge, Reliance/Pipavav, BDL and Astra. I would like to emphasise that we are seeking to enlarge our partnerships in India and we are negotiating with the local industry to make this happen. We maintain excellent relationship with the government offices, the DRDO, the forces and the industries and we are looking to expand our activities in India. One of Rafael's goals is to enlarge our activities around the globe and especially in India.

Electro-optical payloads for Mini UAVs

Hand-launched Mini UAV with a Controp EO payload

Mini UAVs have been a longstanding need of land forces, and the recent Defence Acquisition Council decision to accord Acceptance of Necessity for some 600 Mini UAVs for the Indian Army (*see Vayu VI/2016*) has re-energised the ebbing interest of many OEMs in this 'on-again, off-again' programme that has been through more than a few RFIs and been subject of much debate and discussion in various fora.

A Mini UAV is a means to an end and not the end itself, which is to carry out real time remote reconnaissance. This is an aspect which is occasionally confused or lost sight of. It is therefore imperative that equal, if not more, importance is given to the sensor payload of a Mini UAV. Depending on the application, payloads could be of many different types. However, this discussion in is limited to the impending procurement case, and therefore restricted to the most basic and commonly used purpose of remote reconnaissance of the area of interest of a battalion commander in the visible and thermal (infrared) spectrum by electro-optical (EO) sensors.

Platform Requirements

Mini UAVs are essentially airborne vehicles, which afford ease of transportation, assembly, launch, operations, recovery and disassembly by one or two persons. In the case of the Indian Army requirement, the system is to be capable of remote sensing in nearly all weather conditions, by both day and night. Certain salient characteristics of a Mini UAV system for such an application would therefore necessarily be as follows:

Transportability: The Mini UAV system as a whole (including the associated equipment) must be lightweight, to enable carriage by a maximum of two soldiers. It should lend itself to quick and simple assembly and disassembly to facilitate immediate deployment and rapid evacuation. Ideally, it should be capable of launch with minimal or no site preparation and without assistance of any additional equipment than what is carried.

Ease of Operation: The Mini UAV should be easily operable by non-technical persons having minimal training. It should have either very simple landing procedures, or an auto land capability.

Rugged and Reliable: Since these platforms will be used extensively in the field, at the battalion level or even lower, the operating conditions will be harsh and unforgiving. Mini UAVs inherently fly at low altitude and speed, which makes them vulnerable to enemy fire. Additionally, the landings of these UAVs are normally harsh, making them prone to damage. The system should therefore be rugged and reliable to withstand the operating conditions, as well as low cost to facilitate easier repair and/or replacement.

Flexible EO Payload: Having day/night and all weather capability that can be quickly selected mid-mission without recalling the UAV to switch or adjust payloads is essential. Visibility issues such as smoke and dust obscuration on the battlefield manifest themselves unexpectedly and without warning, demanding the greatest flexibility from a Mini UAV's EO payload.

Stealth and Endurance: The Mini UAV should be adequately stealthy (visually and aurally), so that tactical areas or targets of interest are not made aware of platforms' deployment. Similarly, platform endurance multiplies the tactical effect of a Mini UAV, either through increased reach or greater time aloft over an area of interest.

Sensor Attributes

From the aforementioned characteristics of Mini UAV flying platforms, certain key requirements of the EO payload can be surmised:

Size: An EO sensor should be small enough to fit within the space provided in the Mini UAV and also cause minimal drag, thereby facilitating better endurance, speed and manoeuvrability. Additionally, a smaller basic size increases the possibility of incorporating multi-sensor payload or stabilisation.

Weight: This is a major consideration, since heavy sensors would necessitate counterweights to be added to adjust platform centre of gravity, thereby increasing the overall weight of the system, impacting speed, endurance and manoeuvrability. Keeping sensor weight low is key to managing overall platform performance.

Low power: In addition to the resultant low consumption of power owing to less drag and low weight by virtue of its size and weight, the power consumption of the electro-optical payload by itself should be as low as possible. This will facilitate availability of more power for other electronic systems such as communications/datalinks, and would also enhance endurance.

Field of View: To enable greater situational awareness, it is essential that the image be adequately stabilised. This is an imperative and cannot be ignored especially for a Mini UAV, which normally flies low and therefore requires a stabilised gimbal to actively control the sensor line of sight. A field of view that is very narrow could be problematic since it becomes difficult to maintain the angular position of the UAV relative to the target. On the other hand, if the FOV is too wide, there would be a loss in resolution forcing the UAV to fly even lower and thereby being vulnerable to detection and enemy fire. Essentially, a stabilised continuous zoom capability is highly desirable for a Mini UAV payload.

Multi Sensor Payload: Dusk and dawn, as is well known, are tactically critical periods of the day when high alertness is imperative. Low light conditions created due to dust and smoke in the battlefield, fog, mist and so on, may also render the day channel ineffective and to avoid recalling the UAV for change of sensors, a multi sensor payload becomes operationally imperative.

Sensitivity/Frame Rate: When thermal contrast of a scene is low, high sensitivity becomes necessary to be able to detect and recognise targets. Also, owing to the speed of the UAV, the imagery seen is very dynamic and to avoid jerkiness, a fast frame rate becomes essential.

Catapult launched Mini UAV with a Controp EO payload

Standardisation: A standard video protocol like PAL/NTSC is preferable over a custom video signal that requires specialised hardware to be deployed to the field.

Ruggedness: In nearly all cases, payloads are placed either ventrally or on the nose of a Mini UAV, and need to be ruggedised to withstand the rough landings that these platforms will normally make at unprepared sites in the field.

Cost: Since Mini UAVs are prone to damage, it is important that payloads are low cost, without sacrificing performance. Life cycle costs and maintenance requirements should also be minimal to ensure that the platforms are available in the field, and not constantly being worked on at depots.

The listed attributes for Mini UAV platforms and payloads are not exhaustive but cover almost all of the most essential considerations. Israel's Controp Precision Technologies has a complete range of high performance gyro-stabilised observation payloads used for day and night surveillance for airborne applications, weighing as little as 300 grams. These EO sensors provide some of the most innovative solutions for surveillance and reconnaissance in the world today, and are operationally proven in the most challenging defence and security environments.

Controp has specifically designed two multi-sensor payloads, one each for Micro-UAV and Mini-UAV platforms, namely the MICRO-STAMP and the M-STAMP. The MICRO-STAMP is a 300 gram gyro-stabilised payload that provides a dual FOV uncooled IR camera and a day camera with a continuous zoom lens while the M-STAMP is a 1.3 kg gyro-stabilised multi sensor payload incorporating an uncooled IR camera with a continuous optical zoom lens, a day camera, and a laser pointer.

The Indian defence company Defsys Solutions Pvt Ltd and Controp have entered into a strategic partnership for manufacturing Controp's entire range of electro-optical products in India, and have commenced operations at their Gurugram facility where some of the products are already under production for the Indian Army. Defsys is one of the few Indian companies to have the ready capability to immediately achieve the requisite indigenous content for a 'Buy Indian' project as mandated under the revised Defence Procurement Procedures released in 2016 (DPP-2016). Defsys is an Indian-registered company providing end-to-end solutions to support Indian defence and homeland security forces with design, development and manufacturing expertise in the fields of electro-optical sensors, military electronics, simulators, test equipment and complex electronic integrated RF systems. They have successfully executed a number of projects for the Indian Army, Air Force, Navy, various DRDO laboratories and HAL and possess the necessary licences and quality certifications for manufacturing such products in their 45,000 sq ft facility at Gurugram, which also includes a Class 10000 clean-room.

Colonel Shishir Gupta (retd)
General Manager – Land Systems,
Defsys

The Power of Co-operation

EUROJET makes the case for AMCA

An RAF Eurofighter in flight with its two EJ200 engines in reheat (photo: Angad Singh)

As development of India's Advanced Medium Combat Aircraft (AMCA) progresses, selecting a suitable engine for the type becomes an increasing imperative. The AMCA programme, while still relatively early in its design and development phase, is believed by the Aeronautical Development Agency (ADA) to hold immense potential to replace a wide range of IAF aircraft, while simultaneously increasing the Air Force's capabilities as the aircraft will be a generation ahead of what the IAF currently fields, or is considering, for its requirements (*see Vayu V/2015 for a detailed report on the AMCA programme*).

Certainly, a decision on the aero engine must be taken well before detailed design begins leading to the prototype stage, and while there have been recent pronouncements from various industry players pledging support to the programme and offering to co-develop existing engines in India, there is little clarity from either the Aeronautical Development Agency (ADA) or from the intended user of the type, the Indian Air Force, on what the capability priorities are for the AMCA. It is important to establish a matrix of priorities during the development stage to avoid creating an impossible 'wish list' of demands that will inevitably cause problems down the road. An added benefit of this approach is that it allows an early forecast of available technologies and their maturity levels, significantly de-risking development, particularly if there is good communication between the user and developer.

The greatest technology risk, and arguably the Achilles' heel of the Indian aerospace industry at large, is that of turbine engines. The experience of HAL's HF-24 Marut must be recollected and, it is therefore clear, that this aspect of the AMCA will require definition at the earliest, to avoid letting a single issue derail programme schedules and budgets, as was the case with the de-novo Light Combat Aircraft (LCA) and its de-novo Kaveri engine. It is therefore surprising that there still remains little clarity on the AMCA's engine beyond that it will be "a foreign solution". While ADA is casting its own net far and wide in search of a modern engine with reasonable growth potential, the Indian Government is separately engaging with the USA on a Jet Engine Technology Joint Working Group (JETWG). This is precisely the sort of 'crosstalk' that can delay design and development efforts, particularly when these efforts hinge on selection of a suitable powerplant!

From various public pronouncements given by ADA, IAF and MoD officials, the AMCA will not be developed alongside a new engine, so clearly lessons have already been imbibed. Whatever be ADA's decision,

this must be made in consultation with the Government (i.e. the MoD) and the Indian Air Force, and it will have to factor in the imperatives of good project management, the IAF's capability requirements and the Government's policy aims.

Advanced Technologies

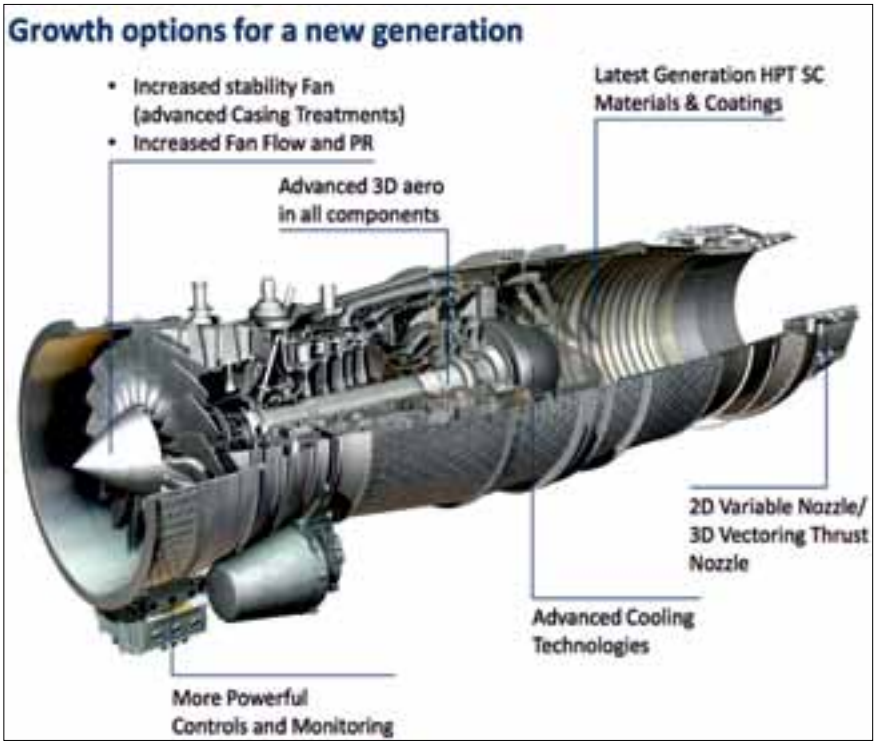
In a comprehensive presentation during the 2015 *Subroto Mukerjee Seminar* organised by the Centre for Air Power Studies (CAPS), EUROJET outlined the key modern and futuristic technologies for combat jet engines. The talk covered the demanding requirements to be met by current and future engines, the challenges in design and engineering as well as a plethora of development paths ahead, not limited only to EUROJET, but looking at work taking place around the world.

Different missions in different flight operation regimes put differing demands on engines. High-altitude reconnaissance is carried out very differently from low-level strike and both are far removed from the rigours of air-to-air combat. In the past this was rarely an issue, as aircraft were typically tailored for a narrow set of requirements, allowing them to perform in concert for maximum effect only where needed. However, advent of the multirole fighter has placed great demands on aero engine designers. An airframe-engine combination now has to excel at low-level penetration, sustained air combat, all sorts of ISR flight profiles… and everything in between !

Future developments appear even more daunting as additional requirements are thrown into the mix. The fighters of tomorrow, particularly low-observable designs with fuel and munitions carried internally (including the AMCA) will necessitate engines with increased thrust-to-weight ratios, but also higher efficiency to offset the fundamental limitations in utilisation of internal volume. The aircraft can carry either more fuel or more weapons, but not both. The concept of life cycle costs has come into prominence in recent times and will doubtless have bearing on any future procurement decisions anywhere in the world. It is a simple adage that more complex parts create higher sustainment costs as a result of high part-count, labour intensive maintenance, or both. Therefore an engine must be relatively simple in design, manufacture, and maintenance to remain cost-effective in the long term.

Balancing these contradictory requirements with what is available globally, either off the shelf, or after a short development cycle, is the task ahead of ADA and the IAF. For instance, the concept of supercruise – sustained supersonic flight without reheat – has come into vogue over the last decade or so. Yet Air Forces all over the world rarely use this capability, even if their aircraft are capable of supercruising. While supercruise is certainly more efficient than using afterburners to maintain a given supersonic speed, it is still many times worse than simply cruising in the high-subsonic range. In fact, many of the efficiency gains of supercruise can be matched and even exceeded by cruising at a higher altitude.

EUROJET projects that Mach 1.4 flight at 50,000 ft in part reheat is actually more efficient than cruising at the same speed without afterburner at 36,000 ft. On the other hand, creating the ideal airframe-engine combination with a prime focus on supercruise results in significant penalties in subsonic flight regimes and loiter times. Sometimes the simplest solution to a problem may lie in operational changes, and not technological! It seems clear then, that it is not a good idea to design an aircraft and engine combination with the express purpose of supercruise. It would be far better to focus on more mission-relevant capabilities such as internal volume, sensor/self-protection suite and so on. If the resultant aircraft can supercruise, then gains an additional capability with no negative impact to the overall programme. The same applies to trade offs in performance versus stealth, and vice versa.



The Choices

The AMCA engine selection will have to be based on a current production engine, with an eye on size, weight and growth potential. EUROJET believes that the EJ200 offers the best combination of present-day performance in a compact package, with real potential for further development to improve on every important aspect as noted above. Preliminary work is already underway on assessing a range of changes to the high- and low-pressure sections of the compressor and turbine stages, the afterburner section and the exhaust nozzle. The Company's presentation in 2015 indicated that specific fuel consumption, increased manoeuvrability, ownership costs and a 20+ per cent increase in thrust were realistic targets for further development of the EJ200. Indeed, many of these developments – such as vectoring nozzles – are only awaiting formal requirements from existing or future customers, and can be delivered relatively quickly.

Angad Singh

VAYU Interview with Thom Breckenridge, VP Global Sales – India for Boeing Defence, Space & Security

F/A-18 Super Hornet: "the best choice for India"

The emerging requirements of the Indian Navy for new carrier-borne fighters became apparent during the Navy Chief's Navy Day press conference held in December 2016. Admiral Sunil Lanba, Chief of Naval Staff, stated that the Navy was looking to procure fighters to operate off India's present and future carriers, and a formal Request For Information (RFI) issued in January went into greater detail on the IN's fighter plans (*see Vayu I/2017*).

Boeing's F/A-18 Super Hornet, the US Navy's frontline strike fighter, with over 583 aircraft delivered, is an option that India could consider. In an interview with *Vayu*, Thom Breckenridge, Vice President, Global Sales-India for Boeing's defence business outlines what would make the F/A-18 an ideal fit for India's naval requirements.

VAYU: Share with our readers why the F/A-18 Super Hornet from a capabilities perspective would be a good fit for the Indian Navy?

TB: Introduced in 2007, the F/A-18 Super Hornet Block II is the world's preeminent carrier capable aircraft. The F/A-18 Super Hornet was designed from day one for carrier operations and is the world's preeminent carrier capable aircraft. It is a combat proven, supersonic, all weather multirole fighter jet with a defined US Navy flight plan to outpace threats into the 2040s. Every Super Hornet to the US Navy has been delivered on cost and on schedule.

With designed-in stealth, an AESA radar and many other advanced technologies that

is ideal for mission requirements of the naval aviator, the F/A-18 Super Hornet is the most advanced aircraft of its kind in operation today and will provide operational benefits to the Indian Navy's existing and future force structure.

For example, every Super Hornet has a buddy refueling capability that can extend time on station, range, and endurance. Additionally, the Super Hornet can provide close and deep air support through the Active Electronically Scanned Array (AESA) radar targeting data and reliable data links.

The Advanced F/A-18E/F Super Hornet's multi-mission capabilities include battle-space situational awareness, counter stealth targeting, greater range and increased acceleration, improved survivability and reduced signature, and room for growth.

The Super Hornet's benefits of being a twin-engine aircraft help provide the warfighter a margin of safety that does not exist in a single-engine platform. A single-engine aircraft is likely lost due to engine malfunctions or loss of thrust while a twin-engine platform can lose an engine and still safely return to the carrier.

With multi-role capabilities, advanced technologies with room to grow, and low acquisition and sustainment costs, the Super Hornet is the clear choice for India.

VAYU: Boeing has said that as a twin-engine fighter, the cost to operate F/A-18 Super Hornet over its lifecycle is still cheaper than a single engine fighter. Please explain how !

TB: Sure, the F/A-18 Super Hornet is a twin-engine fighter that costs less to operate than single engine fighters. It not only has a low acquisition cost, but it costs less per flight hour to operate than any other tactical aircraft in US forces inventory. Part of its affordability is because the Super Hornet is designed to need far less maintenance, which translates into the high mission availability it is known for.

Ease of maintenance (supportability) results in lower maintenance man-hours per flight hour. Plus, the Super Hornet does not require any scheduled Depot-Level maintenance and the engine does not require any scheduled maintenance between overhauls. Further, Boeing's active production line and robust supply chain allow the company to offer the most affordable platform.

VAYU: Will the F/A-18 be able to operate off all three aircraft carriers, including the STOBAR INS Vikramaditya and Vikrant, as well as the Indigenous Aircraft Carrier-2, which could be CATOBAR?

TB: Boeing has completed extensive analysis and done some testing on F/A-18s compatibility with Indian carriers. We have assessed that the Super Hornet is capable of launching off a ski-jump carrier and could be operated from Indian carriers.

VAYU: What about Boeing's 'Make in India' offer on F/A-18 Super Hornets?

TB: The F/A-18 Super Hornet offers unmatched opportunity for 'Make in India.' Boeing is prepared to bring its global scale and supply chain, its best-in-industry precision manufacturing processes, as well as the company's unrivalled experience designing and optimising aerospace production facilities to bear in both expanding India's aerospace ecosystem and helping realise the 'Make in India' vision. The Super Hornet – with more composite content than its competitors – is in fact uniquely well positioned in India's path to the Advanced Medium Combat Aircraft (AMCA).

Boeing's 'Make in India' plans include an entirely new and state-of-the-art Super Hornet production facility that can be utilised for other programmes such as AMCA. Boeing will partner with Indian industry to develop the right capabilities as efficiently and cost effectively as possible to integrate these suppliers into the global supply chain.

Boeing and our current industry partners are having robust discussions with suppliers in India about building Super Hornets. There are 800 suppliers building the Super Hornet today and we plan to build on our existing partnerships to grow India's aerospace ecosystem and make India a global exporter.

We understand that the Indian Air Force has a need for additional twin-engine aircraft as the IAF retires Jaguars, MiG-29 and Mirage aircraft in the future. We likewise understand there is a need at the Indian Navy as well. We are having on-going discussion with the IAF, IN and MoD on the best way for India to meet its fighter needs while building an indigenous industrial base.

VAYU: Describe the changes Boeing has made to the F/A-18 Super Hornet to keep its technological edge in the 21st century.

TB: The Super Hornet is continuously evolving to outpace future threats. Boeing and the US Navy have laid out and maintained a robust spiral development approach to the Super Hornet that provides updates to the aircraft's subsystems and software every two years to outpace threats for decades to come. The future insertion of conformal fuel tanks will reduce weight and drag while expanding range of the Super Hornet. As part of this development path, the enhanced GE 414 engine offers an opportunity for collaboration with Indian firms to use in the LCA and future AMCA.

Certifiable Predator B now named

'SkyGuardian'

In January 2017, General Atomics Aeronautical Systems, Inc (GA-ASI), launched a 'Type-Certifiable' (STANAG 4571) variant of its Predator B, called *SkyGuardian*, before an audience of international dignitaries from nine nations including the United Kingdom, Italy, France, Australia, Belgium, The Netherlands, Denmark, Norway, and the United States.

The SkyGuardian is the result of a five-year long company funded effort to deliver a remotely piloted system that can operate under the airworthiness requirements of non-military airspace. The aircraft leverages the legacy of the multi-mission Predator B fleet, which has amassed nearly two million flight hours, and can fly in excess of 35 hours with airspeeds up to 210 knots, and reach altitudes of more than 14000 metres. "The SkyGuardian name reflects the system's role in protecting ground forces, as well as its performance of non-military missions like border-surveillance, maritime patrol, and relief over-watch in cases of natural disaster," said Linden Blue, CEO GA-ASI.

SkyGuardian will be fully compliant with NATO's UAV System Airworthiness Requirements (defined in STANAG 4671) and the UK's DEFSTAN 00-970. GA-ASI also collaborated with the LufABw (German Military Aviation Authority) to define airworthiness requirements for German airspace. To facilitate qualification testing, GA-ASI is building three company-owned aircraft, along with two airframes designed specifically for full-scale fatigue and static testing to satisfy type-certification requirements. It plans to deliver the first production aircraft in 2018.

The aircraft can host a variety of sensor and communications payloads and is capable of transmitting high-resolution video to manned aircraft and ground forces. The maritime patrol variant of this system, designated SeaGuardian, is designed to support open ocean and littoral surface surveillance for border patrol, coast guard, and disaster relief missions.

Also, in January 2017, General Atomics Aeronautical Systems Inc (GA-ASI) secured a two-year, $56.7 million order from the US Air Force as part of an existing Foreign Military Sales (FMS) deal to expand Spain's current fleet of MQ-9 Reaper Unmanned Aerial Vehicles (UAVs). The US Defence Department noted that GA-ASI will also provide associated UAV equipment under Spain's MQ-9 Exportable Block 5 Procurement programme. The US Air Force Life Cycle Management Centre serves as the contracting party since the FMS deal is administered by the USAF.

Weapon Locating Radar from BEL

Weapon Locating Radar deployed at Deolali

In 1948, just a year after Independence, the Government of India entrusted the task of establishing a radar and electronics factory to the Ministry of Defence. It was from this authority that Bharat Electronics Limited (BEL) was instituted in Bangalore in 1954. BEL is a pioneer in India in the field of radars and has, in collaboration with DRDO labs, been designing and manufacturing land-based, airborne and shipborne radars for defence and civilian applications since 1964.

Some of the important radar projects executed by BEL over the years are 2D Low-Level Surveillance Radar (INDRA II), 2D Surveillance Radar Element (SRE), Flycatcher Radar, Battle Field Surveillance Radar Short Range (BFSR-SR), Battle Field Surveillance Radar Medium Range (BFSR-MR), 3D Surveillance Radar (Rohini), 3-D Tactical Control Radar, Flight Level Radar and Troop Level Radar for Akash Missile System and Doppler Weather Radar Mk–II for ISRO and the MET department. New generation 3D and 4D Radars with AESA technology are in the pipeline.

BEL has added another feather to its cap with the development and successful trials of Weapon Locating Radar (WLR), which is a field artillery radar system capable of locating enemy artillery batteries or shell-firing guns, mortars and rocket launchers with great precision and guiding own artillery fire to neutralise the enemy targets. The radar system is configured on two Tatra vehicles: Radar Vehicle and Power Source-cum-BITE Vehicle. The system has been developed jointly by the Military Radar Strategic Business Unit of BEL's Bangalore Complex and Electronics & Radar Development Establishment (LRDE), a DRDO laboratory based out of Bangalore.

BEL, along with technical support from LRDE, initiated the indigenous development of WLR in May 2002 and completed realisation of the engineered model in 2010, incorporating new technologies/techniques like flexible waveforms through Digital Pulse Compression, improving the average power of transmitter for higher (5%) duty cycle, software improvements for better clutter handling and incorporation of Power PC-based Programmable Signal Processing Unit (PSPU) and weight reduction. The system has cleared all the five phases of trials, viz., actual firing trials in the forward ranges of Pokhran and high altitudes of Sikkim, EMI/EMC evaluation by MCE, Mhow, maintainability evaluation by MAG and environmental evaluation by DGQA in November 2011. The project also won the prestigious Raksha Mantri's Award for 'Import Substitution' in 2011.

Following recommendations of the Technical Oversight Committee and Contract Negotiation Committee, BEL signed a contract for supplying of 30 WLR systems: 10 systems configured with high altitude kit for TATRA vehicles to the Indian Army on 30 December 2015. The First off Production Model (FoPM) of WLR came out in January 2016, with the proactive involvement of DGQA agencies, MAG and User Directorate. Qualification Tests for improved subsystems and acceptance tests of all sub systems were completed, and firing trials successfully completed in mid-April 2016. The high altitude version of WLR and other versions for the plains have been manufactured and are under different stages of inspection and evaluation, production of the entire quantity of WLRs to be undertaken and supplied as per the terms of the contract.

WLR Power Source-cum-BITE vehicle

Mr M V Gowtama, BEL CMD

MKU: taking extra weight off helicopters

In modern combat scenarios, helicopters play a major role against enemy forces and terrorism, and it is therefore essential for them to be well protected. Expensive rotorcraft routinely weather harsh conditions but can be vulnerable if they are not also designed for ballistic protection.

While armouring a helicopter is an absolute necessity, equally important is the right armour solution, so that added protection doesn't compromise flying characteristics of the aircraft and affect safety and capability. MKU employs leading-edge technologies in achieving mission critical modular protection for helicopters, while keeping the weight to the minimum possible. The firm's 6th Generation Polyshield V6 armouring technology uses advanced materials and techniques that reduce the weight of armour for helicopters by approximately 40% compared to conventional armouring solutions.

Concerning multi-role operations and survivability requirements for utility and assault helicopters, MKU designs helicopter armour kits using the proprietary 'Modulare Schutz Technik', which uses precision engineered composite armour panels along with patented aerospace-grade attachment systems. These retrofittable armour kits are in line with a particular recipient aircraft's specifications, and do not require re-certification of the aircraft for airworthiness.

A helicopter cabin with visible floor armour

Saab's Deployable Aircraft Maintenance (DAM) Facility

DAM in tropical areas

To ensure effectivity, air operations must rely on an intricate complex of support activities. A key is the ability to carry out aircraft maintenance wherever necessary, thereby ensuring that the weapon systems deployed are continuously available for operational use.

In Saab offering its Gripen multirole fighter to India, the highest operational availability and reliability is assured, with the fastest turnaround and minimal support, leading to sustained high sortie rates. This enables commanders to extract the maximum from minimum of resources.

The new generation Gripen is designed for constantly changing operational requirements in the face of increased air defences, and is considered to be "the most cost effective combat aircraft for the Indian Air Force".

The complex security challenges that India faces today would require that its air force be deployed in remote locations, which would require mobilisation of resources to maintain its assets at forward operating bases with highest serviceability. An air force must have the flexibility and preparedness to rapidly place its fighter aircraft in hangars and therein carry out a wide spectrum of support and maintenance actions so that the aircraft is ready for operational use – even in harsh and isolated locations, far from main bases. Creating such a stable and secure environment is vital to mission success and personnel safety.

When operating in remote conditions, it is imperative that appropriate maintenance capabilities exist to ensure aircraft availability and mission readiness at all times. "The Swedish Air Force has utilised the concept of deployable maintenance capability in several missions as well as during joint international exercises. With our Deployable Aircraft Maintenance Facility one can carry out additional preventive and corrective maintenance tasks at organisational level at the forward operating base. The robust design and minimal maintenance requirements make it ideal for semi-permanent use, or to complement or even substitute stationary facilities at main bases," states Christoffer Rashdan, Business Development Director at Saab's Support and Services business area.

DAM in desert conditions

The Gripen multirole fighter was from the outset designed for flexible deployment with a small logistics footprint. This was because of the Swedish Air Force's policy during the Cold War for operating from a number of dispersed bases across the country. Keeping staff resources, support systems and spares to a minimum was therefore the Swedish Air Force's the highest priority. As a result of this, Gripen was designed to operate from short runways with minimal infrastructure which meant that it could operate from regular highways, all this leading to logistics flexibility.

The Deployable Aircraft Maintenance Facility comprises an aircraft hangar and maintenance containers outfitted to serve as workshops, storage facilities for spares and support equipment, pilot locker rooms and offices for maintenance and mission planning and follow-up. In addition, the integrated Barracuda multispectral camouflage provides protection for aircraft and personnel against modern warfare sensors.

Courtesy: Saab

UAC and its MiG-35

In January 2016, Russia's United Aircraft Corporation (UAC) officially declared the Mikoyan MiG-35 multi-role fighter as available for domestic and overseas customers. The MiG-35 is Russia's first AESA radar-equipped fighter available for export, and was launched with much fanfare at a ceremony in Lukhovitsy, where UAC subsidiary RAC-MiG assembles the fighter. President Vladimir Putin has remarked that the MiG-35 has "good export potential" considering the customer base of its predecessor, the legacy MiG-29.

Commander of Russia's Aerospace Forces (VKS) Colonel General Viktor Bondarev says that "the MiG-35 is fit for varied operations thanks to its long range and ability to deploy precision-guided air-to-surface munitions." The aircraft was

unveiled with a targeting pod mounted under the starboard engine intake trunk, although no air-to-surface munitions were displayed. Instead, a full complement of eight air-to-air missiles was fitted to the aircraft. Bondarev also stated that the MiG-35 would be the mainstay of the VKS lightweight fighter force, and would replace existing aircraft "in a phased manner."

UAC is also expected to renew its MiG-35 offer for India, which is currently seeking an unspecified number of light fighters (albeit single-engine) for the IAF and 57 carrier-borne fighters for the Navy.

(photos: Vladimir 'Vovick' Karnozov')

BIG WINS FOR QUEST

Airbus Awards ODC 2.0

QuEST Global has been awarded the Wing & Pylon Design Centre ODC Contract by Airbus Group (Airbus) for the second time in a row. Commenting on this key distinction, Dr. Ajay A Prabhu, *Chief Operating Officer,* **QuEST Global** said, **"**QuEST has been driving transformation through engineered solutions in the aero industry for about fifteen years now and a significant portion of this engineering journey has been in close partnership with Airbus. During this decade-long partnership, in multiple capacities we have aligned our organisations closely and have co-created innovative solutions."

QuEST Global has also been conferred with the biennial *Engineering Strategic Suppliers* (E2S) *Award/Status 2016* by the Airbus Group. QuEST was presented this prestigious award during the 2016 Airbus ETS Supplier Summit in Airbus Toulouse, France, for "delivering design engineering solutions with maximum innovative productivity improvements" approved by Airbus.

UTAS recognises QuEST for Productivity Improvement

Meanwhile, QuEST Global has been conferred with the *Global Engineering Productivity Improvement Implementation Award 2015* by UTC Aerospace Systems (UTAS). Congratulating the QuEST team on this occasion, Natalia Khandros, Strategic Sourcing Manager, said that "QuEST Global always comes up with creative ways to expedite things that needs to be done and this is why QuEST had significant submittals of approved productivity projects in 2015. QuEST's expertise in data analysis and ability to continuously improvise and thereby make a significant impact to productivity is much appreciated."

Commenting on Zinnor's rating QuEST Global as "Leaders in the Aerospace &Defence domain", Raman Subramanian, Senior Vice President & Head of New Business Development & Marketing, QuEST Global said that "this global recognition is a re-affirmation of our vision to be the most recognised and trusted global engineering partner to our customers. Over the years, we have driven transformation for our customers through engineered solutions and leveraging our cross-industry expertise. As we stride towards a digital world with agile application in a mechatronic environment, we remain invested in building capability and co-creating innovation in the connected era".

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Israel orders 17 more F-35As

The Government of Israel has approved purchase of a further 17 Lockheed Martin F-351 Adir (F-35A Lightning II) aircraft. With these additional aircraft, the Israeli Air Force will have a total of 50 F-35Is. The first Israeli F-35I made its maiden flight at Fort Worth on 25 July, the second followed on 8 August, both then flown to Nevatim Air Base to join 140 'Golden Eagle' Squadron.

Second J-31 prototype

A second J-31 prototype built at Chengdu Aircraft Corporation reportedly incorporates several changes over the first prototype, PT-1, which flew at the Zhuhai show in 2014, while a third J-31 prototype is also being built. Refinements have been made to the aerodynamics and radar cross section (RCS), making it "stealthier", and there is a new avionics layout, described as the 'Advanced Avionics Concept'. The weapons bay of the second prototype is larger than the first (which could house four legacy SD-10As), facilitating carriage of up to six SD-10A BVRAAMs with foldable fins. The J-31 will eventually have a Chinese engine (probably the WS-13A) but early aircraft will be powered by the Russian-origin RD-93 as presently in the JF-17 Thunder. The KLJ-7A AESA radar is being considered for the J-31 and is also an option for the Pakistan Air Force's Block 3 JF-17s.

The J-31 is being developed exclusively as an air defence fighter for the export market, with the Pakistan Air Force speculatively the first off but AVIC is optimistic the PLAAF and the People's Liberation Army Navy (PLAN) too will also acquire these. In an interview, the J-31's chief designer Sun Cong expressed the hope that the J-31 would follow the J-15as a carrier-borne fighter. However, officials from AVIC said that the aircraft was only intended for export as a competitor to the F-35. As for Pakistan, this country is reportedly considering acquiring 30-40 J-31s.

More Sukhoi fighters for Russian Air Force and Navy

Even as the Russian Air Force aerobatic display team, the *Russian Knights* received its first Sukhoi Su-30SM fighters, four being delivered from the factory at Irkutsk to the team's base at Kubinka on 14 October, the Russian Navy has taken delivery of Sukhoi Su-30SMs, handed over at the production plant in Irkutskv on 28 November.

More numbers of another Sukhoi type, the Su-34, have been delivered to the Air Force, a third batch of the type handed over during 2016. Four had earlier been delivered on 31 May, followed by five on 30 August, these being operated by the 277th Bomber Aviation Regiment at Komsomolsk-na-Amur/Khurba.

More F-16Cs for Iraq

A further four F-16IQs have been delivered to the Iraqi Air Force, joining 9 (Fighter) Squadron. The single-seat F-16C Block 52s bring the total in country to 14 (eleven F-16Cs and three twin-seat F-16Ds). Meanwhile, the Iraqi Air Force is procuring an additional Lockheed C-130H Hercules through the Excess Defence Article (EDA) programme. Currently, the IqAF operates three C-130E Hercules, which are also former USAF aircraft, along with six new production C-130J-30 Super Hercules. Iraq had previously requested three additional surplus Hercules aircraft from the US DoD.

First Oman Typhoons

According to reports, BAE Systems has flown the first two Royal Air Force of Oman (RAFO) Eurofighter Typhoons, both on the same day, from the factory's airfield at Warton, Lancashire. Under a contract signed in 2012, the RAFO is acquiring an initial batch of 12 Typhoons, comprising nine single-seat aircraft and three twin-seaters. The Typhoon order is part of a larger deal which also includes eight Hawk Mk.166 Advanced Jet Trainers, the first of which is to fly shortly.

Gripen evaluated by Indonesia

With competition underway to replace the obsolescent F-5E/F Tiger IIs of the Indonesian Air Force (TNI-AU), Indonesian Air Chief of Staff Marshal Agus Supriatna has stated that there are several candidates for the Tiger's replacement: the Sukhoi Su-35, Lockheed Martin F-16 Fighting Falcon, Saab JAS39 Gripen, Dassault Rafale and Eurofighter Typhoon. According to reliable reports, Saab has reaffirmed its offer of 14 Gripen C/Ds plus two Globaleyes, the latter using the Bombardier 6000 platform and Erieye ER (extended range) radar system. "The first Gripen for Indonesia could be delivered within 18 months of contract signature." Saab is also offering Indonesia the opportunity to develop the Gripen's software upgrade as part of the proposed technology transfer, while a ten-year export credit facility could be made available, if requested.

Canada orders 18 Super Hornets

Soon after the Canadian Government's decision on 22 November 2016 to launch "an open and transparent competition" to replace the present fighters in its inventory, there will be an interim purchase of 18 new Boeing F/A-18E/F Super Hornets to supplement the Royal Canadian Air Force's legacy CF-18 fleet. The Canadian Government will "enter into discussions with the US Government and Boeing regarding use of these fighters for an interim period to cover the capability gap until a new fighter enters service." The current RCAF fleet is now more than 30 years old and reduced

from 138 to 77 aircraft. Acquiring 18 Super Hornets would alleviate the problem pending a decision on the long-term fighter aircraft requirement. Meanwhile, Canada will continue participation in the Lockheed Martin F-35 Lightning II Joint Strike Fighter programme, which will enable it to maximise benefits of the partnership and provide the option to buy the aircraft, should the F-35 be selected for the RCAF.

Finnish Hornet Replacement RFI

There reportedly have been five responses to Finland's request for information (RFI) for replacement of the Finnish Air Force's F-18C/D Hornets, these coming from Boeing (/F/A-18E/F Super Hornet), Dassault Aviation (Rafale), BAE Systems (Eurofighter Typhoon), Lockheed Martin (F-35 Lightning II) and Saab (JAS39 Gripen E). Finnish Defence Ministry plan to announce the results of this evaluation around April 2017. The RFI seeks estimates on the cost of acquisition, through-life operation and maintenance support, plus details of weapons, training methods and equipment. A formal tender is expected to be issued in spring 2018, with an acquisition decision scheduled to follow in 2021.

Super Hornets for Kuwait

Kuwait will buy 40 F/A-18E/F Super Hornets through a Foreign Military Sale at an estimated cost of $10.1 billion, including support, equipment and training. The US Defence Security Co-operation Agency (DSCA) has notified Congress of this possible sale. The request is for 32 single-seat F/A-18Es and eight twin-seat F/A-18Fs, plus eight spare F414-GE-400 engines and 24 engine modules;

41 AN/APG-79 AESA radars; 44 M61A2 20mm gun systems; 45 AN/ALR-67(V)3 radar warning receivers; 240 LAU-127E/A guided-missile launchers; 45 AN/ALE-47 airborne countermeasures dispenser systems; 12 AN/AAQ-33 Sniper Advanced Targeting Pods; 48 Joint Helmet-Mounted Cueing Systems (JHMCS); 45 AN/ALQ-214 radio frequency counter-measures systems; 45 AN/ALE55 towed decoys; 48 Link-16 systems; eight conformal fuel tanks and 14 AN/ASQ-228 Advanced Targeting Forward-Looking Infrared (ATFLIR) systems. The Super Hornet will eventually replace the Kuwait Air Force's ageing legacy F/A-18C/D Hornets *(see Vayu 25 Years Back)* but the country already has 28 Eurofighter Typhoons on order, with deliveries expected to begin in 2019.

Singapore and Taiwan in F-16 upgrade contracts

Lockheed Martin has been awarded two separate US Air Force Foreign Military Sales contracts for work on Singaporean and Taiwanese F-16s. The first concerns four options against a previous contract to upgrade Republic of Singapore Air Force aircraft, while the second deal, worth $12.3 million, covers developmental support equipment for the Republic of China Air Force. The contractor will provide equipment required for "reliability, performance and sustainability" for 144 Taiwanese F-16s.

Grob 120TP 'Prefects' with RAF

Affinity Flying Training Services have taken delivery of the first two Grob G120TP (Prefect T1s) under the UK Military Flying Training System (MFTS) contract. The aircraft arrived at RAF Cranwell, Lincolnshire on 15 November from the factory in Bavaria. A total of 23 Prefects will be operating from two Lincolnshire airfields, RAF Barkston Heath and RAF Cranwell, replacing Grob Tutor T1s in the elementary training role.

UK Protector UAV Programme

A contract has been signed by General Atomics Aeronautical Systems Inc (GA-ASI) for development of the UK's new Protector unmanned air vehicle. The agreement will have GA-ASI develop its current UAV technology into the new 'Protector', which will be along with Brimstone 2 missiles and Paveway IV laser-guided bombs. The type is expected to enter service with the Royal Air Force in 2021. Earlier, approval was granted for the Foreign Military Sale to the UK of up to 26 General Atomics Certifiable Predator B Remotely Piloted Aircraft (RPA), plus equipment, training and support, at an estimated cost of $ 1 billion. The RAF's current fleet of ten MQ-9A Predators will be replaced by the Protector.

General Atomics Extended Range Avenger

General Atomics Aeronautical Systems Inc (GAASI) have flown its new Avenger Extended Range (ER) unmanned aircraft, the maiden flight taking place on 27 October at the company's Gray Butte Flight Operations Facility in Plamdale, California. With an increased wingspan of 76ft (23m), and 2,200lb (998kg) of additional fuel, the Avenger ER extends the legacy Avenger's endurance from 15 to 20 hours and GA-ASI state that the RPA provides an optimal balance of long loiter intelligence, surveillance, and reconnaissance (ISR) and precision-strike capability, supporting a wide array of sensors and weapons payloads to perform ISR and ground support missions.

Norway orders 5 Boeing P-8A Poseidons

Norway will acquire five Boeing P-8A Poseidon maritime patrol aircraft (MPA), which will replace the Royal Norwegian Air Force's four P-3Cs, two P-3Ns and two Falcon 20ECMs, this taking place in 2021-22. The Poseidon's intelligence systems on board will also enable retirement of the two Falcon 20ECMs in service with the RNAF.

LAIRCM for ROKAF A330 MRTTs

Foreign Military Sale to the Republic of Korea of AN/AAQ-24(V) Large Aircraft Infrared Countermeasures (LAIRCM) systems, equipment, training and support has been confirmed. The LAIRCM would be integrated on four Airbus Military A330 Multi-Role Tanker and Transport (MRTT) aircraft. The A330 MRTT was selected to meet South Korea's KC-X requirement for four air-refuelling tanker aircraft, the first aircraft expected to be delivered in 2018 and the last before the end of 2019.

Turkey orders PAC Super Mushshak

Turkey has signed an MoU covering purchase of 52 Super Mushshak basic training aircraft from the Pakistan Aeronautical Complex. Deliveries will begin eight months after the final contract is signed, the aircraft incorporating glass cockpits and improved environmental control systems. The aircraft will be flown by the Turkish Air Force's 123 Filo at Kaklic Air Base Izmir, and replace the current fleet of Italian-origin SF 260TD trainers.

Nigeria inducts Super Mushshaks

The Nigerian Air Force inducted its first batch of four Super Mushaks at Kaduna on 5 December 2016. These are 'interim' aircraft pending delivery of ten new aircraft ordered under a contract signed on 21 October. Funding of N2.06m ($10.35m) to buy the Super Mushshaks was included in Nigeria's fiscal year 2016 budget, which had been presented by President Muhammadu Buhari. The

aircraft will be used by the NAF's 301 Flight Training School at Kaduna. It is learnt that the Nigerian AF are examining various offers for an advanced jet trainer type, which will enable fast jet training before pilots are posted to operational fighter squadrons. The Nigerian AF have reportedly ordered a batch of JF-17 Thunders from Pakistan and could, logically, also be looking at the Sino-Pakistani K-8 Karakoram to meet the AJT requirement.

Colombia inducts A-29B Super Tucanos

The Colombian Air Force (FAC) will equip its *Grupo Aéreo de Casanare* (GACAS – Casanare Air Group) with Embraer A-29 Super Tucano COIN aircraft. The only combat capability so far were in the form of armed Cessna 208B Grand Caravans. The unit had originally also flown the OV-10A Bronco close air support aircraft, but the type was withdrawn from FAC service by early 2015. The A-29s will be used for missions in the Arauca, Boyocá and Casanare areas to counter armed gangs and other threats to the country, as the type is being already employed on similar operations elsewhere in Colombia.

Panama orders Twin Otter 400

Panama's SENAN (National Naval Air Service) has ordered the Twin Otter Series 400, the contract announced by Viking Air of Canada on 1 November. The aircraft will be operated by the *Escuadrón de Ala Fija* (Fixed-Wing Squadron) of SENAN's GrupAéreo and used to support SENAN's humanitarian aid and relief missions in the country.

Huey IIs for Kenyan Air Force

Six Bell UH-1H-II Huey II helicopters joined the Kenya Air Force (KAF) in early December at Laikipia Air Base, Nanyuki. These are the first of eight Huey IIs being delivered to the KAF, Bell Helicopter having been awarded a contract in September to produce five Huey IIs for the KAF.

53 UH-60As for Afghanistan

The Afghan Air Force is reportedly to receive a large number of US helicopters, with a planned acquisition of 53 Sikorsky UH-60A Black Hawks. These would be provided through the supplemental funding budget to support Overseas Contingency Operations and would procure and modernise 53 of a planned 159 surplus US Army UH-60As that are being divested and replaced by new production UH-60Ms. The Afghan Air Force continue to operate Russian-origin Mi-17s and in mid-2016, still operated 47 Mi-17s.

Airbus AS565 MBe Panthers for Indonesia

Airbus Helicopters has delivered the first three of 11 AS565 MBe Panther helicopters to Indonesia, "ahead of contract schedule", at a ceremony at Airbus Helicopters' headquarters in Marignane, in the presence of representatives from Indonesia's Ministry of Defence and the Indonesian Navy. This follows the contract signature in late 2014 with PT Dirgantara Indonesia for 11 AS565 MBe helicopters. The delivery of the remaining helicopters will run through to 2018.

H215 helicopters for German federal police

The German federal police *Bundespolizei* has signed a contract with Airbus Helicopters for purchase of three H215 multi-role rotorcraft via the purchasing administration of the German Federal Ministry of the Interior. The aircraft will be tasked with a number of roles, among them maritime emergencies and police missions and are scheduled for delivery in early 2019. The *Bundespolizei* currently operates 19 helicopters of the Super Puma family, these being flown 365 days a year in missions as diverse as the transport of personnel over large distances and under difficult weather conditions, including VIP transport, complex search and rescue missions and disaster relief operations.

Bangladesh Army receives Mi-171Sh

Three more Mi-171Sh assault-transport helicopters have been delivered to the Bangladesh Army, the first of a batch of six ordered through Rosoboronexport in April 2015. Russia has provided a $1 bn loan to finance the purchase. These follow delivery of an earlier batch of five Mi-171Shs, which had been ordered in 2013.

First Royal Navy AW101 Merlin Mk4 in maiden flight

The first Agusta Westland AW101 Merlin Mk4 made its maiden flight in October 2016 at the Yeovil facility in southwest England. Leonardo is upgrading 25 Royal Navy Merlin Mk3/3A aircraft to Merlin Mk4/4A standard as part of the Merlin Life Sustainment Programme (MLSP) contract, valued at £330 million. Deliveries of aircraft will start in 2017 and continue through to 2020 with the work being performed at Leonardo's Yeovil facility.

The AW101 Merlin Mk4/4A aircraft are fully optimised for ship operations and includes automatic main rotor blade folding and tail fold. The aircraft are also fitted with the same cockpit as the Royal Navy's Merlin Mk2 aircraft, giving the Merlin fleet a common cockpit featuring five integrated display units, two touch screen units for controlling the aircraft's systems and mission equipment, as well as two cursor control devices for cursor control of the tactical displays.

General Atomics' advanced Arresting Gear System trials

General Atomics Electromagnetic Systems (GA-EMS) have reported that the Advanced Arresting Gear (AAG) system has completed the first fly-in aircraft recovery of an F/A-18E Super Hornet at the Runway Arrested Landing Site (RALS) at Joint base McGuire-Dix-Lakehurst in New Jersey. The F/A-18E fly-in recovery follows more than 200 successful roll-in test arrestments at the site since March, and more than 1,300 dead-load arrestments. "This marks another significant milestone in the successful demonstration and verification of AAG's performance and capability," stated Scott Forney, president of GA-EMS. AAG is a turbo-electric system designed for controlled and reliable deceleration of aircraft recovery operations on carriers. AAG is installed on-board the carrier *Gerald R. Ford* (CVN 78) along with the GA-EMS Electromagnetic Aircraft Launch System (EMALS), which uses electromagnetic technology to launch aircraft from the deck of naval aircraft carriers. "EMALS has successfully completed system testing on CVN 78," according to the company.

Royal Norwegian Air Force tested IRIS-T in air-to-ground mission

Functionality of the short-range air-to-air missile IRIS-T (Infra Red Imaging System Tail/Thrust Vector-Controlled), produced by Diehl Defence, Germany and selected for the Eurofighter Typhoon, F-16, EF-18, Tornado and Gripen, "has been extended." After its initial optimisation for air-to-air operations, procured for short-range (IRIS-T SLS) ground-based air defence, its functionality has been enhanced with an air-to-surface engagement capability. This basic air-to-ground capability provides the ability to acquire, track and engage individual ground targets like boats/ships, small buildings and vehicles and was successfully verified in September 2016 by a test firing from a Norwegian F-16.

P-72As for the Italian Air Force

Leonardo-Finmeccanica has delivered the first two of four ATR 72MPs ordered by the Italian Air Force. Designated P-72A by the Italian Air Force, the aircraft will replace the Air Force's earlier Breguet Atlantics. The contract, signed in 2014 comprises delivery of logistic support services, in addition to the supply of four ATR 72MP platforms, which will be completed by 2017. The ATR 72MPs will be provided with the latest communication systems, able to transmit or receive information in real time to/from command and control centres either on the ground, in the air or at-sea, to ensure coordinated and effective operations. The aircraft will also be equipped with a self-protection system, fully integrated with the ATR 72MP's mission system and avionics.

Additional AW139 helicopters for Italian Service

Leonardo-Finmeccanica has been contracted to supply six additional AW139 intermediate twin helicopters to the Italian Customs and Border Protection Service (*Guardia di Finanza*), including integrated logistic support and training for pilots and technicians. The contract, valued at around €90 million, will increase the Italian fleet of AW139s to eight units. The AW139s will be operated for a range of missions including maritime surveillance and patrol, maritime and mountain reconnaissance, law enforcement and homeland security. The order also includes options for six additional helicopters, allowing the operator to take a further step towards replacement of its ageing AB412 fleet.

AW139s for largest EMS programme in China

Leonardo-Finmeccanica and the Chinese company Sino-US Intercontinental Helicopter Investment have contracted for 30 helicopters in EMS (Emergency Medical Service) configuration comprising Agusta Westland AW139 intermediate and AW169 light intermediate twin engine models. The aircraft are expected to be delivered in 2017 and will be operated by Kingwing General Aviation. With this contract, the presence of Leonardo in China grows stronger with more than 180 helicopters sold to Chinese customers to date, and with 2016 setting a new record with more than 20 helicopters delivered to China that year. The order follows a contract signed by Sino-US earlier in 2016 for 25 AW119Kx helicopters, which has so far placed orders for over 80 helicopters comprising AW119Kx, Grand New, AW169, AW139 and AW189 models.

300th NH90 delivered

On 15 December 2016, NH Industries delivered the 300th NH90 production helicopter, which was to the Spanish Armed Forces. Assembled at the Airbus Helicopters Spanish final assembly line at Albacete, the aircraft will be operated by the Spanish Army's aviation branch, *Fuerzas Aeromóviles del Ejército de Tierra* (FAMET). Till now, 515 NH90 helicopters have been ordered by military operators in 13 countries, and the global in-service fleet has logged over 120,000 operational flight hours with missions including transport, special operations, medical evacuation and combat search and rescue, to naval missions such as search and rescue, and anti-submarine (ASW) and anti-ship (ASuW) warfare. The two versions of the NH90 – TTH and NFH - are in service in Australia, Belgium, Finland, France, Germany, Greece, Italy, New Zealand, Norway, the Netherlands, Oman, Spain and Sweden.

Maiden Flight of Boeing-Saab T-X

The Boeing-Saab T-X prototype made its first flight on 20 December 2016. During the 55-minute flight in St Louis, lead T-X Test Pilot Steven Schmidt and Chief Pilot for Air Force Programmes Dan Draeger validated key aspects of the single-engine jet and demonstrated the performance of this "low-risk design." With its single engine, twin tails, tandem seating, and an advanced cockpit, the Boeing T-X is reportedly "more affordable and flexible than older, existing aircraft". Boeing and Saab had revealed their T-X aircraft in September 2016, with a second prototype currently in ground testing and expected to fly in early 2017. T-X will replace the Air Force's aging T-38 aircraft. Initial operating capability is planned for 2024.

Aermacchi M-345HET flies

Prototype of the new Aermacchi M-345HET (High Efficiency Trainer)made its first flight at Venegono Superiore airfield (Varese, Italy) on 29 December 2016, flown by Quirino Bucci and Giacomo Iannelli. The flight test programme will be completed within 2017. The next tests will check the advanced avionics systems, engine performance and the flight envelope expansion, including altitude, speed and manoeuvrability.

Production–standard Scorpion in first flight

Maiden flight of the first production-spec Textron Scorpion took place on 22 December 2016, from Mc Connell Air Force Base in Wichita which conducted a range of manoeuveres during the one hour and 42 minute flight. The Scorpion was piloted by experimental test pilots Don Parker and Dave Sitz, who verified the avionics and aerodynamic performance as well as a number of aircraft systems. This follows the weapons capability exercise, which was completed in early October. The Scorpion programme aims to develop a tactical aircraft for roles ranging from intelligence, surveillance and reconnaissance to close air support and armed reconnaissance

Emirates fleet being revamped

Emirates has begun to phase out Airbus A330 and A340 airliners consolidating its fleet with the Boeing 777 and Airbus A380. Since January 2015, Emirates has phased out 18 A330s and five

A340s. The airline plans to replace a further 25 aircraft from its fleet over the course of 2017 and 2018. In 2016, Emirates took delivery of 36 new aircraft, consisting of 20 Airbus A380s and 16 777s and the 'next generation' 777-300ER with upgraded Business Class seats.

Etihad Codeshare Agreements

Etihad Airways which has an equity status in Jet Airways, Air Berlin and Alitalia has expanded its codeshare agreement with Hong Kong Airlines, gaining regulatory approval to codeshare on nine additional routes. Etihad will place its codes on Hong Kong Airlines' scheduled flights between Chek Lap Kok and Auckland. Hong Kong Airlines has placed its code on Etihad Airways' flights between Abu Dhabi and Paris, Düsseldorf, Frankfurt, Manchester, Milan, Munich, New York and Zürich.

Meanwhile, Etihad Cargo has launched three new freighter services in Europe, flying Boeing 777Fs from East Midlands and Stansted in the UK and from Copenhagen in Denmark. Etihad Cargo also operates main deck capacity from Amsterdam, Frankfurt (Frankfurt Main and Frankfurt-Hahn), Milan, Brussels and Zargoza.

Air Seychelles Expands

The Airline of Seychelles in the Indian Ocean is expanding its network, adding Düsseldorf and Durban, even while the carrier is increasing its links to Paris from three to four flights per week from March. To support the airline's expansion plans, it will acquire a second Airbus A330, which is scheduled for delivery at the end of March. In addition to flying to Europe, Air Seychelles will also be used to increase capacity on the airline's five weekly services to Johannesburg, Mauritius and Mumbai.

A320 neo for Air Astana

Air Astana has taken delivery of its first Airbus A320neo acquired from Air Lease Corporation which is one of 11 A320 neo Family aircraft contracted for by the Kazakh airline. Configured in a two-class layout, with 16 Business Class seats and 132 in Economy, Air Astana already operates a fleet of 13 A320ceo Family aircraft on the carrier's domestic and international network.

Privatisation of Air Madagascar

Four airlines have reportedly been shortlisted by Air Madagascar as potential strategic partners, who would acquire up to 49% of Air Madagascar. These are Air Austral, Kenya Airways, South Africa's Airlink and Air Mauriius. Malagasy Minister of Transport Benjamina Ramarcel Ramanantsoa has said, "We are on track with the process. Air Madagascar will take to the skies with its new strategic partner during the first half of 2017."

A320s for Air Arabia

Air Arabia has converted five options for Airbus A320 into firm orders with deliveries to begin in the second quarter of 2017. According to Adel Al Ali, Group CEO of Air Arabia, "Today we operate one of the youngest fleets in the world and this approach will continue to drive our fleet growth strategy for the future. Our customers can expect the same cabin comfort and spacious seat configuration with five new aircraft joining the fleet." Air Arabia currently has a fleet of 46 A320s and has been rewarded with the *A320 Family Operational Excellence Award* by Airbus for achieving the highest level of utilisation for the type in the world with 99.8% operational reliability.

14 Boeing 747-8s for UPS

US Cargo operator UPS airlines has placed an order for 14 Boeing 747-8 Freighters and has also taken purchase options on 14 additional airframes. UPS Airlines currently operates 13 747-400Fs. According to the manufacturer, this newest incarnation of 'the jumbo' provides 16% more revenue cargo volume and reduced the noise footprint around an airport by 30% compared with the carrier's current 747s.

ATR 72-600s for PNG Air

PNG Air, the airline of Papua New Guinea will acquire five additional ATR 72-600s, which is a partial conversion of 14 outstanding options for the carrier alongside a firm commitment for six aircraft. The airline took delivery of its first ATR 72-600 in November 2015 and now operates four examples with a fifth due to arrive before the end of 2016. As the CEO stated, "We will progressively phase out previous-generation turboprops – 12 36-seat de Havilland Canada DHC-8-102 Dash 8s – to introduce an aircraft that has become a reference on the regional market worldwide."

First Japanese A320neo operator

Japan's Peach Aviation has signed an order for ten Airbus A320neos and three A320ceos, with a further two examples on order. The acquisition makes the low-cost carrier the first airline in Japan to purchase the latest member of the A320 Family. Peach expects the first current-generation A320 from the order to be delivered during its 2018 fiscal year (ending March 2019), followed by an initial A320neo in summer 2019.

Hanoi-Ho Chi Minh air services

Even as the Delhi-Bombay city pair is listed as the sixth of the world's top 10 busiest routes, based on total number of seats per year flown in each direction, the next is that between the Vietnamese cities of Hanoi and Ho Chi Minh City, with 34 flights per day. The increase in flights has been achieved by Vietnam Airlines and its co-owned subsidiary (with Qantas) Jetstar Pacific. Trinh Ngoc Thanh, Executive Vice President of Vietnam Airlines said: "In an

effort to enhance our capacity to serve customers between Hanoi and Ho Chi Minh City, we have started to operate flights on the hour. This helps passengers to easily remember their flight time and arrange their working schedules in a more convenient manner." Wide body aircraft including Boeing 787s and 777s as well as Airbus A350s and A330s will be deployed on more than 65% of these flights, while the remaining rotations will be operational by A321s. The new generation 787 and A350 airliners will be used during the peak hours.

Fiji orders B-737MAX

Fiji Airways have ordered five Boeing 737 MAX 8s with first delivery in 2018. Currently, Fiji Airways has five 737s in its fleet, comprising one 737-700 and four 737-800s, that are used on short- and medium-haul routes to Australia, New Zealand, Hawaii, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu. The aircraft would be delivered via a 12-year sale and leaseback financing arrangement as part of a package deal with GE Capital Aviation Services (GECAS), Boeing and engine manufacturer CFM International.

Atlas Elektronic to 'modernise' German Navy minehunters

Atlas Elektronik GmbH has received an order from the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) for modernisation of three minehunting vessels of the *Frankenthal*-class (Type 332) in service with the German Navy. The objective is to equip the three boats with the Integrated Mine Counter Measure System (IMCMS) and the underwater vehicle Sea Fox of Atlas Elektronik GmbH. The

vessels will also be given capability for controlling the *Seehund* ROV, which until now has only been integrated on the minesweepers of the *Ensdorf*-class (Type 352). In addition to the shipboard adaptations, a shore based training and testing facility is to be established and put into service.

Chinese aircraft carrier in South China Sea

China's aircraft carrier, the 60,000-ton *Liaoning*, the retrofitted Soviet-era *Admiral Kuznetsov*-class multirole aircraft carrier, conducted exercises in the South China Sea early January 2017. According to the Chinese Defence Ministry, "A naval formation consisting of aircraft carrier *Liaoning* conducted take-off and landing drills in the South China Sea. The formation, which is on a 'cross-sea area' training exercise, involved J-15 fighters as well as several ship-borne helicopters." The *Liaoning* can embark an air wing of 24 Shenyang J-15 multirole fighter jets, and up to ten rotary wing aircraft including Changshe Z-18, Ka-31, and Harbin Z-9 helicopters.

Further, the drill "provided important experience in the build-up of combat capability of the aircraft carrier formation." A Chinese Foreign Ministry spokesperson corroborated the *Liaoning's* activities stating that "the carrier and accompanying ships are testing weapons and equipment and running exercises in the relevant waters of the South China Sea."

Vietnam orders missiles from India

Following Indian Prime Minister's visit to Vietnam in September 2016, when too the government of India extended Vietnam a $500 million credit against supply of defence equipment and training, Vietnam Navy personnel are already under training in India on Russian-origin *Kilo*-class submarines, while Vietnam Air Force personnel would receive training with the IAF on Sukhoi Su-30MKI fighters. The Vietnamese have reportedly also requested supply of BrahMos supersonic long range missiles plus Akash surface-to-air missiles.

In an expected reaction, a Chinese government spokesman has stated that, "If the Indian government genuinely treats its enhancement of military relations with Vietnam as a strategic arrangement or even revenge against Beijing, it will only create disturbances in the region and China will hardly sit with its arms crossed".

Russian withdrawal from Syria

The Russian government is reportedly "scaling back its military presence in Syria", starting with withdrawal of its warships from the eastern Mediterranean including the aircraft carrier *Admiral Kuznetsov* from the waters off the coast of Syria.

Earlier in October 2016, Russia's parliament had ratified the decision to indefinitely maintain a military deployment in Syria aimed at what it said was "peace and stability in the region". On 23 December, Russian President Vladimir Putin ordered the expansion of Russia's naval facility in Tartus. It is not known if this subsequent decision to scale Russian operations in Syria is permanent or is a tactical move.

Russia to supply weapons to the Philippines?

In a major geo-political development, the Philippines are reportedly in discussion with the Russian government for the supply of"sophisticated weapons including aircraft and submarines". This is linked with recent statements by Philippine President Rodrigo Duterte which have thrown the future of Philippine-US relations into question with angry outbursts against the former colonial power even as the Philippines are taking steps to boost ties with China and Russia.

In his address, Russian Ambassador Igor Anatolyevich Khovaev, on board the visiting Russian naval ASW frigate *Admiral Tributs*, stated that "It is not a choice between these partners and those ones. Diversification means preserving and keeping old traditional partners and getting new ones. So Russia is ready to become a new reliable partner and a close friend of the Philippines.…We are ready to supply small arms and light weapons, some aircraft, helicopters, submarines and many, many other weapons. Sophisticated weapons. Not the second-hand ones."

Two Russian warships made a four-day visit to the Philippines in the first week of January 2017, the first official navy-to-navy contact between the two countries. Rear Admiral Eduard Mikhailov, head of the Flotilla of the Russian Navy Pacific Fleet, said Russia wanted to hold maritime exercises with the Philippines "to help combat terrorism and piracy."

ID/IQ mortar weapon systems contract for Elbit

Elbit Systems of America, has been awarded an 'Indefinite Delivery/Indefinite Quantity (ID/IQ)' contract for the production of mortar weapon systems, with a maximum value of up to approximately $103 million to be performed over five-year period."We are extremely pleased to continue our partnership with the United States Army by supplying our warfighters with these mortar weapon systems that enhance their mission effectiveness

and provide the necessary precision and flexibility to address current and future threats," stated Raanan Horowitz, president and chief executive officer of Elbit Systems America.

Saab receives order for Carl-Gustaf M4

Saab have been contracted for their new Carl-Gustaf M4 multi-role weapon system,this being the fourth (and most significant) customer for the system since its launch in late 2014, with deliveries to take place during 2017. This new version is of a lightweight design (weighing less than 7 kg), has a round counter and intelligent features, such as compatibility with future innovations like the intelligent sighting systems and programmable ammunition, which collectively offer significant operational improvements for the soldier.

Black Blade 2016

Exercise 'Black Blade 2016', a Special Forces helicopter tactical training exercise facilitated by the European Defence Agency (EDA), was held from 14 to 30 November 2016 at the Florennes air base in Belgium. 'Black Blade' is one among a multitude of multinational helicopter exercises conducted in Europe.

The European Defence Agency (EDA) was established in 2004, addressing a need perceived by several European States for a common security and defence policy. One of the tasks of the EDA is to facilitate a training programme in which helicopter units in Europe work together. The EDA helps participating Member States in addressing military helicopter-related issues with a central training element under the Helicopter Exercise Programme (HEP). The HEP currently has fourteen participating Member States: Austria, Belgium, the Czech Republic, Germany, Greece, Finland, Hungary, Italy, Luxembourg, the Netherlands, Portugal, Sweden, Slovenia and the United Kingdom. To improve operational skills of helicopter crews throughout Europe, the HEP plays an increasing role in the deployable helicopter capabilities for contingency operations. HEP exercises focus on individual, environmental and multinational training, increasing interoperability through practical experiences, sharing of operational experiences and developing common tactics, techniques and procedures. The aim of the HEP is to be integral part of the reinforcement of European capacity and interoperability within a time frame of ten years. Between 2009 and 2016 more than 206 helicopters, 1,320 aircrews, and almost 13,000 staff members in supporting roles, have participated in various HEP exercises. Exercises take place in several countries such as France, Spain (Ex *Azor*), Italy (*Italian Blade*), Portugal (*Hot Blade*), Finland (*Cold Blade*) and Belgium *(Green Blade* and *Black Blade*). In addition to these field exercises, the Helicopter Tactics Symposium has been held in Luxembourg a total of four times, during which delegations from Member States discussed ideas and theories.

Special Forces Exercise

Black Blade 2016 was focused primarily on operations with the Special Forces and fast tactical missions. *Black Blade* participants had a unique opportunity to practice planning and execution of these kinds of missions within a common framework of European partners. Several European partner countries participated in this exercise, with helicopters supplied by three countries: Belgium, Austria and Slovenia. Belgium, which was also the host nation for the exercise, took part

with seven helicopters during the training – two NH90 Caïmans and five Agusta A109s. All Belgian helicopters were from Beauvechain, where they are assigned to 1 Wing. The Austrians participated with two S70 Black Hawk helicopters from Tulln-Langenlebarn and three Agusta-Bell AB212 helicopters from Linz-Hörsching, while the Slovenians participated with a single AS532 Cougar from the Slovenian Helikopterski Battalion out of Ljubljana. Besides these three countries, observers from Hungary, Italy and Switzerland were also present for *Black Blade* 2016.

The helicopters operated from Florennes for duration of the exercise, with missions flown to various locations in Belgium, such as Camp Elsenborn in the Ardennes and Arendonk in the north. Most sorties took place around or after sunset, owing to the nature of the exercise. The objective of *Black Blade* 2016 was two-fold: first, to improve interoperability at the tactical level between helicopter units and ground troops during a Special Forces deployment, and second, to integrate routines to maximise interoperability during normal operational tasks. The training involved various combined air operations (COMAO) scenarios, conducting realistic joint missions in challenging environments, and familiarisation with equipment of the participating countries. Specific elements of training included low-level flying, formation flying, Forward Arming and Refuelling Procedures (FARP), and artillery deployment – all conducted in daylight or at night. Training specific to special operations involved personnel recovery missions, night flying, Medevac, and Close Combat Attack (CCA). All special operations missions were flown around sunset and after dark, and had to be planned much more carefully, owing to the dangers of operating in a relatively

Soldiers fast roping from an Austrian Black Hawk

A Medevac-configured Belgian A109 in action during the exercise

small area without helicopter crews being able to seeing each other.

The first specific technique that was imparted was the 'fast rope' technique, during which the helicopter hovers above a small area and soldiers will slide down along ropes for a rapid intervention action. Another technique that is used for SOF insertion into an area is skydiving from a helicopter and this too was practiced, with SOF soldiers jumping out of a helicopter at medium altitude. Then on to the most commonly used method of evacuation in the world of SOF operations : Special Patrol Insertion & Extraction (SPIE). During SPIE, a helicopter hovers at low altitude with a rope under the fuselage. Soldiers on the ground hook themselves onto the rope and are carried away from the dangerous area very quickly by the helicopter. The SPIE method is one of the fastest ways to extract soldiers from enemy territory, and requires the helicopter to be exposed to enemy fire for a very limited period of time. In addition to fast roping and SPIE, the helicopter can also just land in the field during an action, and this method was also repeatedly trained during *Black Blade*. To protect the helicopter and troops on ground, techniques such as air-to-surface fire training were also practiced. These courses took place at the shooting range where helicopter gunners could fire at targets on the ground with live weapons.

Exercise day at Elsenborn

Several media events were arranged during the exercise, one of which was at the Belgian Army base at Elsenborn. During the 'raid' at Elsenborn, the opposing force captured a High-Value Person (HVP) and the Special Forces were tasked to rescue this HPV. From Florennes, a taskforce was sent out to the Elsenborn base, some 120 kilometres away. One of the most important aspects of

A Belgian Caïman flying low at the Elsenborn exercise area

An Austrian AB212 seen at sunset over Florennes

Medevac training in progress during the exercise

such a raid is the difference in flying speeds of the helicopters. Not all helicopters fly at the same speed and differences in fuel capacity, load carrying ability and so on affected the helicopters and the mission planning. For some long(er) range missions, an intermediate refueling site had to be setup to refuel and re-arm the helicopters en route to their objectives. The taskforce reached Elsenborn at sunset, and began by first securing the Landing Zone (LZ) at dropping of Special Forces on the ground while armed helicopters circled the perimeter. After a gunfight with the opposing forces, the HVP was rescued and extracted in a helicopter. During the second phase, a MEDEVAC helicopter flew in to recover the wounded, followed by recovery of all remaining personnel.

'Distinguished Visitors Day'

During *Black Blade 2016*, a Distinguished Visitors Day (DVD, or VIP Day) was held at Florennes air base on 30 November. The EDA's top leadership, Spanish diplomat Jorge Domecq (EDA Chief Executive) and Italian MEP Federica Mogherini (EU High Representative), were in attendance. Mogherini and Domecq witnessed demonstration of the latest developments during the common European helicopter training, while Domecq also had personal meetings with participants of the exercise. He later gave a brief speech to the audience and the media, explaining that the tenth edition of the HEP was truly a milestone for the EDA, and that the HEP already has a great reputation when it comes to improving interoperability and skills. The HEP contributes to the readiness for deployment, and is also a cost-effective and efficient way to exchange the best skills between European militaries, he said. Furthermore, he noted that the HEP is an ideal platform for learning helicopter techniques, tactics and procedures for joint operations, with the added value of practicing large-scale joint and combined missions. Domecq was particularly grateful for the contribution of the Belgian Armed Forces and Florennes air base for hosting *Black Blade 2016*. In addition to the EU leaders, the DVD was also attended by representatives of the EDA States, the European Parliament, the Military Committee of the EU and the Belgian military as the host of the exercise.

Lessons and Future Training

Exercise *Black Blade* was developed as a building block in a larger concept as part of the HEP. The training was started with a Combat Enhancement Training and Force Integration Training (CET & FIT) phase. Next came cross-training, which was carried out by flying small COMAO missions. With this structure, participants could build a mutual understanding of each other's equipment and Standard Operating Procedures (SOPs). Later during the exercise, the complexity and number of activities during the COMAO missions became more intense.

Beside the exercise on its own, there was also an international Mentor Team present during the exercise. This team is composed of members of the Helicopter Tactics Instructor Course (HTIC), which training programme teaches tactical instructors helicopter operations. These mentors were invaluable for supporting the EDA Chief Instructor, intensively monitoring the participants during the planning, execution and debrief phases of the exercise. The mentors during *Black Blade* were from Germany, Sweden and the United Kingdom. The mentors ensure that the lessons that are learned during *Black Blade* will be integrated in the next series of HEP exercises.

The results of exercise *Black Blade 2016* will be thoroughly analysed and the lessons learned will be incorporated into future exercises. The first feedback from the participants in this Special Forces exercise was very positive, with new inputs gained at the tactical level as well as the operational level. "The international co-operation partners have once again ensured that there has been learning from each other's tactics and procedures. The EDA will continue the development of a European programme to support the Member States, aimed at high-end capabilities based on harmonised training programmes and the use of the best national training centres."

The next step for the EDA will be to accept new Member States that will join the HEP and ensuring the continuity of the long-term programme. With the current progress the EDA can develop future training initiatives in consultation with its Member States. This logic has already been applied to exercises with fixed wing aircraft. An example is the European Air Transport Fleet (EATF), which has been established in cooperation with the EDA. The European Tactical Airlift Centre (ETAC) in Zaragoza, Spain is used for the training of transport units in Europe. Future editions of the HEP are expected to take place in Hungary in 2017 during exercise *Fire Blade*. Later there will be also an exercise in 2018 in Portugal and in 2019 in the Czech Republic. In 2020 the HEP exercise is likely to be hosted by the Netherlands and Belgium, but this is still to be confirmed.

Text and photos:
Joris van Boven and Alex van Noije

Ancient Aviator Anecdotes

Air Vice Marshal Cecil Parker on VISTAK at Hakimpet

The Indian Air Force (IAF) and I share the same year of birth – 1932. With the passage of time I find myself (temporarily) the oldest living ex-Commandant of the Air Force Academy (1983-85) and similarly, the oldest ex-Base Commander of Air Force Station Hakimpet (1975-77). Both are co-located with this long retired (1986) air veteran and neither ever fail to extend an invitation to the annual Air Force Day functions; 2016 was no exception. On the wet evening of 8 October 2016, accompanied by my successor and our wives, I found myself night-driving carefully to Hakimpet, the closer of the two establishments. We received a warm welcome from the AOC and much appreciated the valet parking service provided to all the air veteran guests. Climbing stairs at the age of 84, one has to now be particularly cautious, but there was no shortage of young helping hands to steady our entry into the Officers Mess I had built 40 years ago.

While catching up with old friends and enjoying the hospitality and entertainment, my wife brought over a young lady officer of the technical branch of the IAF no older than our granddaughter. She had apparently read my articles, and requested my wife to introduce her. Observing the hearing-aids in both my ears, she thoughtfully spoke slowly and clearly above the rising noise of the party. She expressed her interest in the meaning and origin of the word 'VISTAK,' which had just been projected on the screen, and wanted to know my "experiences at Hakimpet." I explained that VISTAK was only an acronym I had created in 1976 from the initial capital letters of the six aircraft that had till then been based at Hakimpet, i.e. Vampire, Iskra, Spitfire, Tempest, Alouette (Chetak) and Kiran, but not in their actual chronological sequence. In 1951 the IAF had taken over Hakimpet airfield to base the Conversion Training Unit (CTU), re-located from Ambala. As a newly commissioned Pilot Officer I was posted here in 1952 to undergo my fighter conversion on Spitfire and Tempest aircraft, one of which I had to bale out from, owing to a fire in the air. In the late 1950s, as a Flt Lt QFI, I had a brief tenure instructing on the Vampire as at JTW / FTW Hakimpet.

In 1975, as Group Captain, I was posted to command the station. My two-and-a-half year tenure included induction of the Polish Iskra trainer into the IAF. We were responsible for Phase II flying training on both Iskra and Kiran aircraft simultaneously, while Helicopter Training School (HTS) provided rotary wing training on Alouette (Chetak) helicopters. We actually had 84 aircraft in our Hakimpet hangars, comprising 50 Iskra, 24 Kirans and 10 Chetaks. I was able to do my helicopter conversion with HTS and led the first 12 Iskras to Jamnagar and back (via Nasik) so that our pilot trainees were able to carry out live firing practice at Sarmat Range, as well as their navigation sorties. Our ancient World War II vintage cinema hall (and only meeting place for the station) was given a facelift and named 'Vistak'. In 2005 (in retirement) I was invited to the decommissioning of the Iskra after 30 years of service at Hakimpet. I wonder how many IAF officers have had the experience of witnessing the phase-out ceremony of an ac they had inducted?

I concluded the potted history of my links with Hakimpet by pointing out to the young lady that, despite the passage of a near half-century, the last two aircraft comprising 'Vistak' (Alouette/Chetak and Kiran) still continue to provide flying training at Hakimpet.

This admirable feat by man and machine calls for a salute from the oldest member of 'Team Vistak.' !


Vampire


Iskra


Spitfire


Tempest


Alouette (Chetak)


Kiran

25 Years Back

From Vayu Aerospace Review Issue I/1992

Soviet aircraft presentations

The Sukhoi Su-27 strategic air defence fighter was demonstrated to the Indian Air Force in December 1991, at Air Force Station Hindan. At about the same time, a Mikoyan delegation is reported to have offered the MiG-31 strategic air defence fighter for the IAF, although it is known that India does not consider either the Su-27 or the MiG-31 as "relevant" to its air defence requirements.

Czech L-59 offered as AJT

The Czechoslovakian L-59, an updated version of the L-39 Albatross jet trainer, has reportedly been offered to the IAF to meet its Advanced Jet Trainer requirement. Although the overall performance of this Czech type does not meet the IAF's ASR, presentations were made to the Ministry of Defence but the views of the IAF have not officially been made known. In an interesting side-development, a visiting Soviet delegation is reported to have met the Indian Defence Minister and discussed the relevance of the Czech L-39/59, "a jet trainer which is compatible with fighters from both the Mikoyan and Sukhoi design bureaus."

Indo-US defence supply plans

A usually reliable source in Washington DC has reported that a high-level US industrial and government delegation will discuss possible purchases by the Indian Air Force of American hardware and move the dialogue from the theoretical to the practical realm. High on the agenda will be procurement of US equipment to modify MiG-21s so the IAF's fleet does not depend on Soviet supplies. However, in a significant statement Air Headquarters at New Delhi is believed to have conveyed to the US side during the last visit that India was not interested in Northrop's offer to transfer an assembly line for the TF-5 jet trainer, as its performance was "beyond" the IAF's training requirement.

Karwar naval base progresses

The Environment Ministry has given a conditional clearance to the Rs 350 crore *Project Seabird* naval base at Karwar in Karnataka, which will become the biggest base of the Indian Navy. This will be the sixth that the Indian Navy will have, covering more than 8,000 acres along the coastal stretch between in Karwar and Ankola. The naval authorities have identified three additional spots totaling 17,000 acres south of Belekeri and North West of Ankola for future expansion. The Karwar base will have a naval air station exclusively for the use of the Navy. Among the other sites considered were Porbandar and Janjira, but both were ruled out for various reasons including the security aspect considering their proximity to the Baluchistan coast. Karwar's virtues include a deep harbour, availability of land for expansion and its safe distance from Pakistan's striking range.

Restructuring of Air India

The new Chairman/MD of Air India would like a drastic change in the organisational structure of the Airline for speedy decision-making to respond to growing challenges by other airlines in the region as well as international ones. Outlining some of the immediate tasks, he said an investment of Rs 2,000 crore was on the anvil over the next four years which would include the purchase of four Boeing 747-400 aircraft and augmenting the hangar and engineering capacity by August 1993. A 10-year roll-over fleet renewal plan had been formulated which would help lower the average age of aircraft.

Pakistan negotiates for Mirage 2000s ?

In a significant development reached during the visit of the Pakistan Prime Minister Nawaz Sharif to Paris in mid-January, France has agreed to sell 40 Mirage 2000E multi-role fighters for the Pakistan Air Force. The defence-sales agreements also include sales of submarines, minesweepers and air defence radars to Pakistan and is seen as a direct consequence of the suspension of all US economic and military aid to Pakistan since October 1990. Recently, US Senator Larry Pressler, who was the main force behind the stoppage of US aid, visited both New Delhi and Islamabad and reiterated that Pakistan possessed nuclear devices, putting in serious doubt any further supplies of F-16s. The PAF has "on order" another 71 F-16s but even spares for the existing three-dozen F-16s have been withheld, leading to poor serviceability.

Spares for PAF F-16s

The United States has agreed to make available to Pakistan the spares it badly needs for its F-16s, albeit through a route considered expensive and time-consuming. Islamabad would have to make the purchases directly from the manufacturers on a commercial basis, but export licences for the same would be provided by the US Government. Reportedly, most of the 40 F-16 aircraft Pakistan had procured from the USA in the eighties have been grounded "for want of spares." The initial lot of F-16s were delivered in the first two phases of the military pact signed with the US after the Soviet invasion of Afghanistan in 1979. In the third phase, 11 F-16s were to be provided on grant by the Americans at a cost of $23 million each.

F/A-18 Hornets in Kuwait

The first three of 40 F/A-18 Hornet fighters Kuwait is buying from the United States arrived in Kuwait in late January 1992. The start of F/A-18 deliveries into Kuwait represents the first step to enhance the capability of the Kuwait Air Force in air defence. The F/A-18s are intended to serve as a front line of defence for Kuwait and are replacements for the Kuwait Air Force's fleet of A-4KU Skyhawk attack aircraft and Mirage F.1 fighters. The Kuwait Air Force had selected the F/A-18 as its fighter of choice after an extensive flight evaluation in 1988.

Tale Spin

Welcome, Women, Welcome !

Those of the fair sex apprehensive of travelling alone by air can now relax because the National carrier Air India have reserved two rows of seats 'for women only' on domestic flights from January 2017. This is perhaps the first time such a gender-specific reservation is being implemented by an airline anywhere in the world – although it is very much in keeping with other modes of transportation in India.

We are like that only !

Spicing it up !

One of India's leading airline, whose catchy slogan is ***Red, Hot and Spicy,*** have made themselves even more spicy by getting Bollywood actress Sunny Leone to sell her brand of perfume in-flight. According to the merchandise subsidiary of SpiceJet, this is set to give a real boost to the airline ancillary revenues, but something which will certainly also enhance the carrier's attraction, SpiceJet having ordered over 200 new airliners in January 2017.

Loony Beer !

Should our young scientists succeed in brewing beer in a canister sent to the Moon aboard an Indian lunar vehicle, it could indeed be a giant hop for mankind ! Actually, brewing beer on the Moon has a certain resonance, though. After all, the ancient link between the legendary elixir *soma* and the Moon is well known in India. The experiment would also put an entirely difference spin on the ersatz alcohol hitherto going by the name of moonshine, given its connotations of non-conventional brewing methods. Drinking lunar beer while on the Moon, however, may have unseemly consequences : wet burps due to lack of gravity !

(*Courtesy: Economic Times*).

Hawai Dhaba

For most air travellers, in-flight food may be just about tolerable but thanks to an entrepreneur at Ludhiana, people can now dine in an aeroplane and order their favourite dishes, served hot and in plenty ! 'Hawai Adda' is much more than a Dhaba, being opened for the public in mid-December 2016. Housed in an airliner (albeit grounded) this is not just a restaurant, but also a cafe, bakery and open for family events : many in fact made it there for New Year's Eve. Located on the Ferozepore Road, Punjab's first airplane restaurant is on the road which leads to the important Indian Air Force base at Halwara.

How appropriate !

Ghar Wapasi !

Those criticising under-utilisation of the IAF's gargantuan C-17s perhaps did not take into account their unusual deployment in airlifting around 10,000 Indians stranded in Saudi Arabia owing to "an economic slowdown in the Gulf". Parliament was assured that "no Indian would go hungry", alluding to the fact that these poor workers had remained without jobs – or food – and so the Globemaster's winged their way to and from Arabia, bringing them home.

Ghar Wapasi in style !

Afterburner

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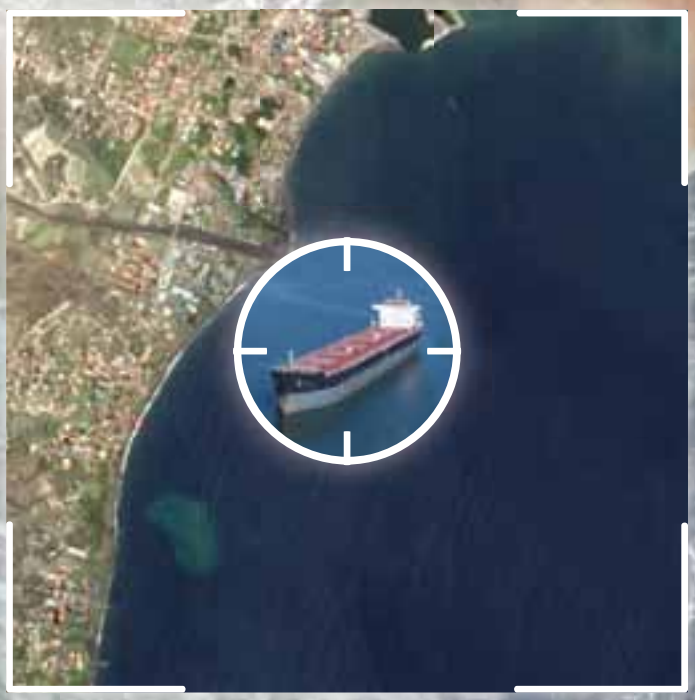

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