

VAYU

III/2017

Aerospace & Defence Review



Airbus and India

UDAN takes off

A Second Chance

**New wings for the
Albatross**

LCA Navy Dilemma

**Indian Navy's anti-ship
missiles**

**USN's new aircraft
carrier**



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Cover : Airbus A321neo during runway water trials (photo courtesy Airbus)

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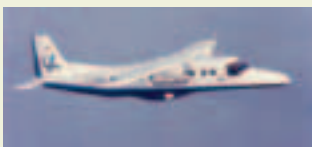
Aerospace & Defence Review

III/2017

30 UDAN takes off

The Regional Air Connectivity Scheme, popularly known as UDAN (Ude Desh ka Aam Nagrik) has been launched with first flight from Simla to Delhi in late April. There are select airlines to operate on 128 routes to 70 airports.

31 A Second Chance



In this critical review, Vayu takes readers back 25 years when the first bold moves were made to introduce regional air connectivity in India. This resulted in establishment of Vayudoot which got off to a rational start with rational commuter airliners (Dornier 228s) but whose original imperatives were abandoned by those in charge, resulting in its ignominious end.

36 Case Study: The Indian Scene, circa 1975



So what has changed? Vayu flies readers back to the early 70's on India's endeavor to launch regional air connectivity services at a time when the then Indian Airlines summarily closed 16 of 70 stations because of non-viability of those air routes. Have the lessons been learnt?

40 Airbus : "competitiveness with efficiency, innovation and diversity"



Airbus marked 2016 with key milestones including service introduction of the A320neo, many of them to Indian operators as also

development of the A321neo (see cover). In a major breakthrough, Airbus made first deliveries of a large number of A320, A330, A350 and A380s to Iran Air even as the Company expect to deliver more than 700 commercial aircraft throughout the world in 2017.

44 Airbus and India



The Airbus story in India began in 1976, when Indian Airlines became the first operator of the A300 B2 in Asia and this start has continued over the next four decades with hundreds of various Airbus models, notably the A320, flying in various colours throughout the subcontinent and on regional international routes.

56 New wings for the Albatross



On 29 March 2016, the Indian Navy's iconic Tu-142M 'Bear-Foxtrot' long-range maritime reconnaissance (LRMR) and ASW aircraft were retired after 29 years of service with INAS 312 ('Albatross'). Having comprehensively covered the Indian Navy's long-range maritime patrol operations out of INS Rajali at Arakkonam in the state of Tamil Nadu (see Vayu VI/2014), Angad Singh of Vayu returned to this secluded air station to bid the Type farewell.

62 To Sea or not to Sea



Future of the LCA Navy is in serious question after the Indian Navy peremptorily rejected the shipborne variant of the Tejas LCA, under development at ADA for over a decade. In a swift follow up, Naval headquarters issued an RFI for 57 multi-role carrier

borne fighters (MRCFB) with Admiral Arun Prakash summing up the Navy's dilemma on having to select an aircraft for the next generation aircraft carriers without further delay. However, ADA are continuing with development of the LCA Navy Mk.II as Vayu was specifically briefed.

67 Armed to the Hilt



The Indian Navy's anti-ship missiles give it a formidable prowess, with both surface and sub-surface systems now in operational service. Sarosh Bana of CLAWS reviews the various weaponry with the Navy including air-launched missiles from various platforms.

71 Future Super Carrier



Vayu's correspondent Sayan Majumdar writes on the Aviation element of the US Navy's new Gerald R Ford-class carriers on which he was briefed during his visit to the Euronaval Show in October 2016. This new generation aircraft carrier with revolutionary EMALS system will embark new generation F-35Cs alongside E-2D Advanced Hawk Eyes, a formidable combination.

Also: Rafael's Litening-5; Irkut at LIMA; Second Yasen-class Submarine; Saab RBS 70NG; Pilatus in 2016; 500th Typhoon; Ronneby's Gripens; Greek Recce Phantoms; Frisian Flag 2017; Red Flag 17-2.

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Start privatisation with Air India

As the government firms up its list of state-owned enterprises that it plans to privatise, the number one candidate must be Air India. The government should privatise the airline, into which it has poured more than Rs 40,000 crore: Rs 24,745 crore as equity support since 2011-12 alone, as per the turnaround plan of 2011-12, which promised a total infusion of Rs 30,231 crore over 10 years. Its debt totals over Rs 40,000 crore. The Comptroller and Auditor General finds that the state-owned airline lost over Rs 6,000 crore since 2012-13.

Why should the government of India keep pouring scarce public funds — which would generate far greater economic returns if invested in education, healthcare or physical infrastructure — into an operation that the country's private sector is perfectly capable of carrying out far more efficiently? The answer is blowing in the jet exhaust. The government should exit the loss making airline. But why should any sane investor buy the stake the government wants to flog?

Mismanagement is only part of the reason for the airline's travails. It was a badly under capitalised company for most of its existence, and the merger of Indian Airlines and Air India played havoc with morale, operational efficiency and finances. Most of the revenue had to go to service debt. After the government infused large dollops of equity, things have improved. Air India's employees-to-aircraft ratio has come down from typical Indian public sector levels to globally comparable levels, even if not down to the level of low-cost carriers.

It even claimed to have turned in an operating profit down the line. The state-owned carrier has suffered owing to political interference and gross mismanagement: politicians and civil servants demand and obtain undue privileges, including delaying flights to allow a tardy neta to clamber aboard at the last minute. Once these factors are removed, the airline should be able to run well. The only businesses the government should be in are those that are strategic and beyond the capability of the private sector. Air India does not qualify.

From *The Economic Times*

Flip-flop model

A new regional air connectivity scheme which aims to put smaller cities on the aviation map has been inaugurated. Enhanced connectivity results in economic benefits and should be welcomed. But in India, passengers flying popular routes have already partially subsidised others for over two decades. Now the new regional connectivity scheme, or *Udan*, adds another layer of cross-subsidies to connect small towns. This overly complicated maze does not necessarily make *Udan* commercially sustainable, nor does it yield very many other benefits.

Indian economic policy since independence has revelled in complicated cross-subsidy schemes which shave some money from Peter's pocket to transfer randomly to Paul, while the overall effect is to make doing business more difficult. *Udan* does not appear to depart from this hallowed tradition. For example, the *Udan* flight between Shimla and Delhi has ticket prices that range between the

subsidised Rs 2,500 to the steep Rs 19,000 for similar seats. The PM has stated he would like to see people wearing *hawai chappals* (flip-flops) stepping on to *hawai jahaz* (planes). But in this case — to turn the metaphor — some seats, at least, can go only to the really suited-booted.

Since the *Udan* subsidy will be paid for by boosting fares on popular metro routes flip flop wearers in metro cities, it appears, are out of luck. In this context, Indian aviation may be better off if both Centre and states work on lowering overall taxes in the sector. On busy routes, fees and cess can be as high as 35 per cent of the fare. Instead of sweating the small stuff what government needs to do is to get some big things right. India could, for instance, leverage favourable geographical locations to turn some of its airports into global air traffic hubs, competitive with Dubai and Singapore.

From *The Times of India*

A long haul, no quick fix

The government's reported decision to press ahead with involving the private sector in defence production is welcome. It has been long overdue. However, caution is in order on expectations of cost-competitive competence straightaway. The objective must be to reap long-term gains, in terms of indigenous defence technological capability and cost savings in the medium to the long term. The Indian private sector has two disadvantages, as compared to foreign competitors. They have a captive, limited market for what they produce on orders from the Indian armed forces and are likely to be pricier, when compared with foreign arms manufacturers who enjoy economies of scale.

A prime obstacle to Indian companies acquiring scale is a poor reputation for assured quality after the initial batches, which afflicts Indian manufacturing. This calls for sustained effort to improve the integrity and credibility of Indian manufacturing exports in general, and not just in the defence industry. The second disadvantage is a poor record of research and development, honourable exceptions notwithstanding. It is possible for the government to fund and catalyse the needed R&D, by contracting out research on the lines of the Defence Advanced Research Projects Agency, which identifies product and technology requirements and bids out R&D contracts.

The resultant intellectual property can be licensed to Indian defence suppliers. A network of university departments and stand-alone laboratories in the public and the private sector, drawing top talent with pay and perks besides intellectual challenge, is essential for indigenous capability in advanced defence technologies. Of course, these things can be dispensed with, if all that the armed forces want from Indian private industry are supplies that are not critical on the battlefield. But if India wants to replicate the kind of success that tiny Israel has managed, leave alone the breakthroughs of the military-industrial complex of the US or Europe, the planning horizon has to be long and broad, and not confined to which company would get what kind of order.

From *The Economic Times*



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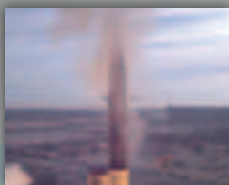


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WHEN RESULTS MATTER

Science diplomacy in new orbit

The successful launch of the South Asian Satellite from Sriharikota onboard the Geosynchronous Satellite Launch Vehicle (GSLV) on 5 May 2017 not only reiterated the technological prowess of India's space agency, but was also a landmark in science diplomacy in the region. This is the first time a communication satellite built and launched by India will be put to the common use of South Asian countries. The Indian space programme is firmly rooted in the utilisation of space technology for peaceful purposes, and the South Asia Satellite symbolises this philosophy.

In fact, international cooperation and peaceful use of space technology (which define space diplomacy) are ingrained in the DNA of the Indian Space Research Organisation (ISRO). The Indian National Committee of Space Research, established by Vikram Sarabhai in 1962, actively promoted international cooperation even before ISRO was born. Between 1962 and 1969, when ISRO was founded, Sarabhai positioned the Thumba Equatorial Rocket Launching Station (TERLS) as an international facility for launching sounding rockets.

Scientists from America, the Soviet Union, France, the UK and West Germany used the facility in Kerala to launch experimental sounding rockets. This is the first time a communication satellite built and launched by India will be put to the common use of South Asian countries. In February 1968, Prime Minister Indira Gandhi formally dedicated TERLS to the United Nations as an international scientific facility open to all members of the UN. An international advisory panel of eminent scientists guided research activities.

Such amalgamation of knowledge and expertise from scientists of leading space agencies of the world helped budding Indian space scientists acquire knowledge and experience. The interaction also resulted in several future bilateral programmes, including the Satellite Instructional Television Experiment (SITE), which pioneered satellite television technology globally. Another high point in science diplomacy came in 1984 when Rakesh Sharma became the first Indian astronaut to travel to space onboard a Soviet space module.

The Soviet Union first proposed to India in 1980 that it could launch an Indian astronaut to the Salyut-7 space station as part of its space diplomacy efforts with friendly countries. The idea was to expand its sphere of influence using its space power. India accepted the offer in August 1981 and joint plans were drawn. Rakesh Sharma joined two other Soviet cosmonauts and was propelled into space on April 3, 1984. The Soviet space diplomacy, however, fizzled after the breakup of USSR, resulting in the Russians reneging on their promise on the cryogenic engine. Science and space diplomacy have acquired a new colour in the 21st century. Like the Soviets in the 1980s, China is offering friendly countries a seat on its manned space missions. China opened the doors to foreign astronauts 10 years after the Chinese first went to space in 2003.

On the other hand, India has offered communication transponders to friendly neighbours. The contrast in science

diplomacy of the two Asian rivals is clear. The goal of Chinese space programme is to establish China as a global space power which is reflected in its thrust on manned missions, while Indian space programme remains focused on using space technology for development. These goals of China and India are reflected in their respective science diplomacy initiatives.

Dinesh C Sharma in *Mail Today*

Credibility at stake in Afghanistan

India is still the most popular country for Afghans — as a friend that has offered substantial aid in education, infrastructure, and community projects, more than what most developed countries did. And yet, the stagnation in Indian policy appears regressive. Indian policy appears to have not changed under Prime Minister Narendra Modi while other powerful neighbours of Afghanistan — Russia, China and Iran — have recalibrated policy to boost the Pakistan-nurtured Taliban, and nudge it towards political settlement with Kabul, hoping that the resulting political consolidation in Afghanistan will be a hedge against the expanding Daesh (Islamic State). Taliban is inimical to Daesh. While the regional political and security constructs are being finetuned, the US has come under suspicion in Afghan eyes. It ousted the Taliban from power in Kabul but benignly permitted its regrouping in next-door Pakistan with the ISI's help, and not asked sharp enough questions of the Pakistanis. Since 2015, Daesh has also expanded its footprint under the nose of American troops.

The use of the so-called “mother of all bombs”, the most powerful non-nuclear detonation device in the world, in eastern Afghanistan, ostensibly against Daesh positions, failed to prove that this was a genuine US fight against terror groups. Daesh is still considered not strong enough to attract such retributive attention, while the Taliban have been treated with kid gloves for over a dozen years. As such, protests erupted in Kabul against the use of the MOAB, which was locally viewed as contemptuous of Afghan sovereignty. High-voltage political preparation seems to be afoot in Afghanistan to challenge the Ashraf Ghani-Abdullah Abdullah government, which accepted the US detonation of the MOAB without demur, by political constituencies that have so far been favourably inclined toward India.

New Delhi, in Afghan eyes as seen in media writings, is perceived as being quietest, and thus incapable of carrying influence in a situation of flux. More, its approach seems to Afghans an adjunct to Washington's thinking. This became more apparent during the visit to New Delhi by US national security adviser HR McMaster. Then India strongly condemned the biggest terrorist attack against the Afghan military in Mazar-e-Sharif and spoke of the need to dismantle the terrorist infrastructure inside Pakistan. This is now par for the course. To be credible in a changing situation, New Delhi needs to nuance its stand from Washington's, and open communication channels with the Taliban with the goal of an Afghan political reconciliation and to help extricate the Taliban from Pakistan's grip, distancing itself in this respect from the Chinese, Russian or Iranian stance.

From *The Asian Age*



Ajai Shukla on the MoD's 'Strategic Partner' policy

On 11 May, at closed-door gathering of private defence industry heads in New Delhi, the ministry of defence (MoD) unveiled its long-delayed policy for identifying 'strategic partners' (SPs)-chosen companies that will partner global 'original equipment manufacturers' (OEMs) in building defence platforms in India. While the MoD has not released details of the new policy, some of those present at the meeting have shared the new policy's scope, and the criteria and procedures for selecting SPs and foreign OEMs that they would partner.

The policy's initial aim is to shortlist six top companies as SPs in four technology segments – *single-engine fighter aircraft, helicopters, submarines armoured fighting vehicles*. A company can be nominated an SP in only one segment, and will have to indicate its preferences while applying.

In 2015, the Dhirendra Singh Committee had recommended selecting SPs to build defence equipment. Last year the VK Aatre Task Force laid down criteria for selecting SPs in ten technology segments, including aero engines, artillery guns, ammunition and smart materials. For now, however, the SP policy has been confined to just four segments to cater for urgently needed battlefield equipment. This includes single-engine fighters, for which the air force has already initiated procurement. The navy

has framed its requirements for its next six submarines under Project 75-I. And the army, after exploring the indigenous option of developing its Future Main Battle Tank with the Defence R&D Organisation, has changed its mind and issued specifications for buying foreign tanks.

For these procurements, which will all involve substantial in-country manufacture, the new policy envisages shortlisting Indian SPs and foreign OEMs through separate, but simultaneous, processes. The first six SPs will be chosen from amongst Indian private firms in a two-stage process. To make it past the 'first gate', aspirant companies would have to meet stipulated financial and technical criteria. They must be Indian companies, as defined in the Companies Act, 2013; and have no more than 49 per cent foreign holding, with no 'pyramiding' of foreign holding.

The MoD's stipulated financial criteria weed out all except large, established firms. These include: consolidated turnover of at least Rs 4,000 crore rupees for each of the last three financial years; capital assets of Rs 2,000 crore; and a minimum credit rating of CRISIL/ICRA "A" (stable).

The MoD will also consider companies' records of wilful default, debt restructuring and non-performing assets. Companies making it past the 'first gate' would undergo "site verification" in what is termed 'Stage II evaluation'. A MoD team would visit company facilities to evaluate financial parameters and technical capability, with equal weightage given to both.

In this second round of financial evaluation, it will be ensured that the applicant company's solvency ratio (external debt to net worth ratio) is no higher than 1.5:1; and its modified solvency ratio (external debt plus financial guarantees to net worth ratio) is no higher than 2.5:1. The debt to EBIDTA (earnings before interest, depreciation, tax and amortisation) ratio can be no higher than 3.

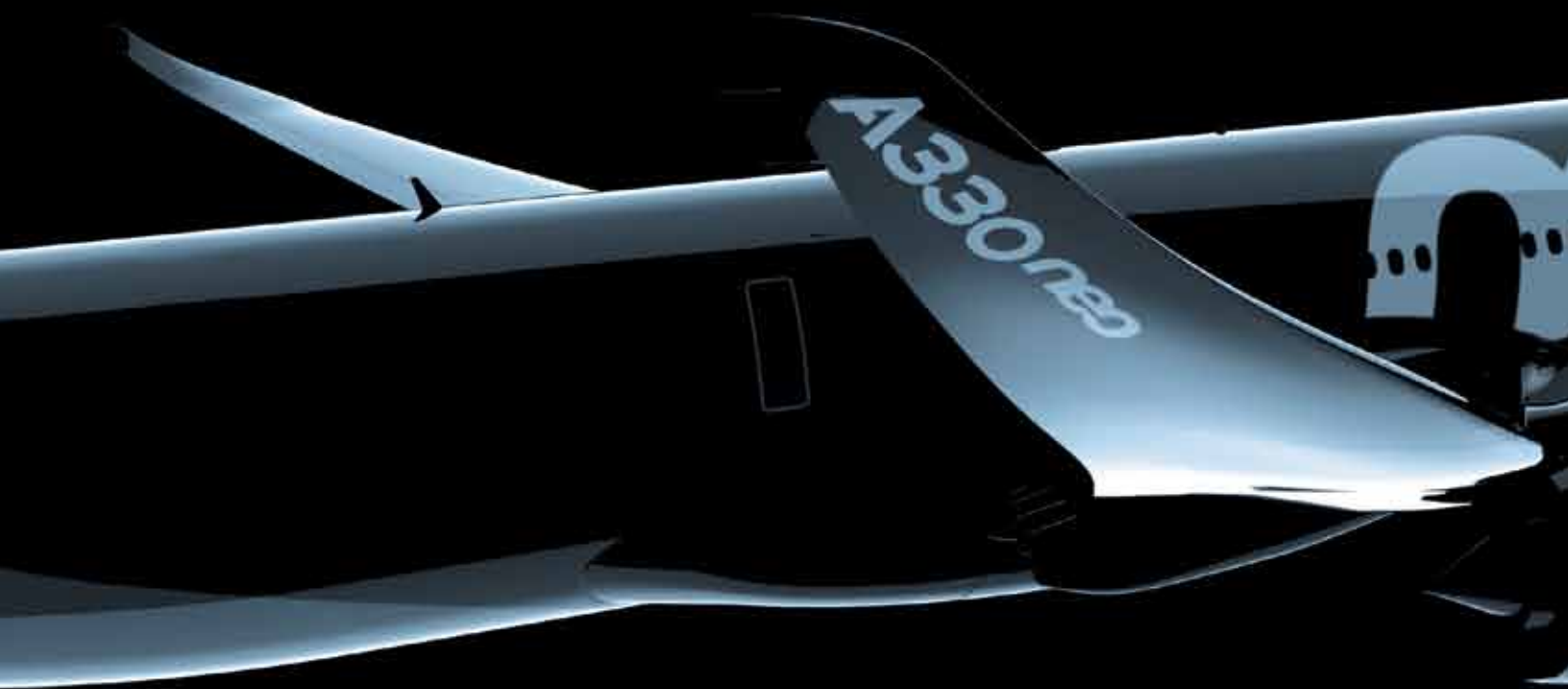
Extracted from Business Standard



Top and right : Artist's depictions of Gripen E and F-16 Block-70

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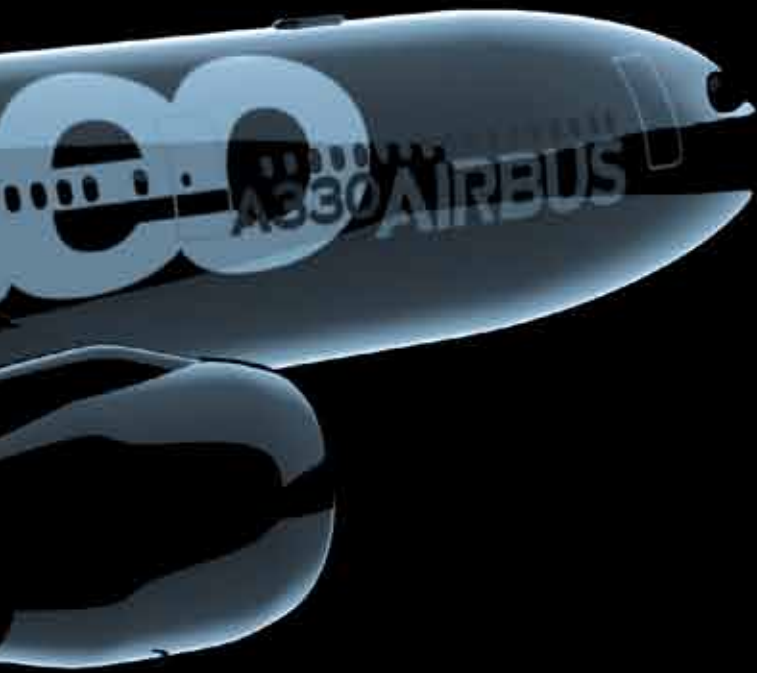
Almost everything about the A330neo is **new**

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Admiral Arun Prakash cautions us to Beware the rhyme of history

It is “Peace for our time”, declared British Prime Minister Neville Chamberlain on 30 September 1938, as he returned from the Munich Conference having tamely agreed to the German annexation of Czechoslovakian territories. This was to be the penultimate act of appeasement before Germany triggered World War II by invading Poland on 1 September 1939.

Well before it sparked this global conflagration, Germany had provided enough evidence of its hegemonic intent and utter disdain for the 1919 Treaty of Versailles, crafted for the purpose of preventing German re-militarisation. In contravention of its provisions, Adolf Hitler introduced conscription, sent his military to gain combat experience in the Spanish civil war and then, in 1936, re-occupied Rhineland. Emboldened by the passivity of Britain and the European powers, this was followed, in 1938, by the forcible union (*Anschluss*) of Austria with the Third Reich because of its German-speaking majority. Craven appeasement and hopeless optimism had set the stage for the Gotterdammerung that was to follow, exactly a year after Munich.

History, according to Mark Twain, “does not repeat itself but it rhymes”. On the 100th anniversary of World War I, Canadian historian Margaret MacMillan had pointed out uncanny similarities between the contemporary geopolitical landscape and the Europe of 1914. She argued in an essay that the same structural forces that led to the Great War a century ago could be in action in 2014. Mercifully, the centennial of WWI came and went peacefully, but MacMillan endorses Mark Twain with her advice: “If we can see past our blinders and take note of the telling parallels between then and now... history does give us valuable lessons.”

Till recently, most of us were convinced that the power of economics and globalisation would not permit another great war. President George Bush was articulating all our fond hopes when he said that, “the spread of democracy and free trade across the world would form the surest guarantee of

world peace.” Yet, the extraordinary growth of trade and investment between China and the US has not served to dampen suspicion and tensions.

On the contrary, according to China expert Michael Pillsbury, there has been a belated realisation in the US that eight Presidential administrations following Nixon’s have actively assisted the ascent of a militaristic China in the mistaken belief that they were helping a weak and victimised country become a liberal, democratic nation. There is angst in America over the notion that by handing over sensitive information, technology, military know-how and expert advice, the US has actually helped the achievement of the “Chinese dream”.

Termed ‘tianxia’ in Mandarin, the ‘Chinese dream’ envisages the establishment of a hegemonic Chinese Empire as the centre of world authority to which other nations must show deference. This may explain the Chinese foreign minister’s patronising remark at the 2010 ASEAN conference to his Singaporean counterpart: “China is a big country and other countries are small, and that’s just a fact.” A brief look at post-1949 events reveals the inherent bellicosity of the Chinese state.

Soon after the end of the Civil War in 1949, the People’s Liberation Army (PLA) drove into the East Turkistan Republic and incorporated it into the Xinjiang Uyghur Autonomous Region. Ever since then, the Peoples Republic of China (PRC) has been engaged in serial strife: The occupation of Tibet and the entry of the PRC into the Korean War in 1950; suppression of the Tibetan uprising in 1959; the Sino-Indian War of 1962; involvement in the Vietnam War from 1965 to 1969; a seven-month long conflict with the USSR in 1969; a major conflict with Vietnam in 1979. Skirmishes in the South China Sea (SCS) and tensions across the Taiwan Strait have occurred with regularity all the while.

Given its growing economic and military strength, revisionist outlook and past record, China can be expected to push

its influence in the region, grab territory and re-write the rules of international conduct to suit its own interests. A recent manifestation of China’s belligerence is the campaign of “cartographic expansion” that it has mounted through the “9-dash line” in the SCS and repudiation of the 1914 McMahon line on the India-China border. Other examples of Chinese intransigence are the illegal creation and militarisation of artificial islands in the SCS and its contemptuous dismissal of UN arbitration on these sovereignty issues.

The choices for India in the face of Chinese hegemony are stark. The constraints of India’s political system render it unlikely that it can bridge the economic and military gap vis-à-vis China within a reasonable time. Distracted as they are by intense political activity, and their preoccupation with interminable election campaigns, our political elite seem incapable of applying themselves to strategic thinking or planning. Even though the Sino-Indian equation is tilted in China’s favour, as a democracy, a nuclear weapon state and a significant economic and military power, it is incumbent upon India to stand firm as a bulwark against regional hegemony.

As it seeks its “manifest destiny”, India badly needs breathing space for growth and consolidation within a democratic framework. But Beijing, hard-nosed as ever, is dropping unobtrusive hints that it could be “peace for our times” if China gets to keep Aksai Chin and India surrenders Tawang. Ironically, this is the time that India’s defence budget has hit a historic low of 1.6 per cent of GDP and its arsenal is full of voids.

Neither appeasement, nor empty bluster — as PM Nehru found to his cost in 1962 — will work with China. The pundits on Raisina Hill are, once again, chanting the mantra of ‘*jang nahin hogi*’ (there will be no war). Should this prophecy prove correct, it will be great news for the country. But chances of it coming true will rise exponentially if India keeps its powder dry by crafting a grand strategy, by initiating urgent reform of our archaic defence structures and by reviving our comatose military-industrial complex.

Major General Ashok K Mehta worries when Party interests override national imperatives

Changing India's Defence Minister seems to have become a new normal for this Government. For a second time in three years, a Defence Minister has been replaced with impunity. Commenting on Manohar Parrikar's legacy as the Defence Minister, a reputed defence commentator noted that he had to be moved from New Delhi to Goa as Chief Minister due to 'party interest' but said nothing about national interest.

This hit the bull's eye, calling him "the reluctant politician in Delhi durbar, Manohar Parrikar is back where he always wanted to be". When asked was it in national interest to leave (the Defence Ministry) abruptly, Parrikar said, "It is not appropriate to discuss this", adding "whatever circumstances evolved, I took the best decision" without qualifying whose interest was best served.

During the three years Narendra Modi has been the Prime Minister, he has treated defence 'step-motherly', giving the Ministry ab initio to Union Finance Minister Arun Jaitley as additional charge. But Modi started his own innings with the military with a bang, spending a large chunk of his first 100 days in office sailing on INS *Vikramaditya*, commissioning INS *Kolkata*, visiting Leh and reassuring soldiers on award of the vote-winning One-Rank-One-Pension (OROP). Modi would then meet the Service Chiefs once a month to hear their *Mann ki Baat*. But the practice was soon discontinued as he did not meet them either on OROP or the Seventh Pay Commission (SPC).

Four months on, he brought in an IIT-qualified Chief Minister Parrikar from Goa as full-time Defence Minister and then gradually lost interest in the military. Two years later, it was only after the 'surgical strikes', from which his party drew maximum electoral mileage, that he said, "The country can never pay back its soldiers for their gallant feat."

Yet, for a second year, defence services were given minimal funding, the current fiscal's defence budget being the lowest at 1.62 per cent of the gross domestic product

since the Himalayan debacle of 1962. Their unfair treatment by the SPC, whose award the Armed Forces have not yet accepted in full, leaves them embroiled in the eternal litany of anomalies. No worthwhile defence reforms — except the limited and ad hoc Shekatkar Committee, whose recommendations are being processed — have been implemented when a great deal was expected from a nationalist party-led Government.

The critical hollowness in defence preparedness, which former Army Chief Gen VK Singh had highlighted in 2013, persists for the most part, though some work has started on fast track. The ad hoc manner in which Modi axed the decade-long search for the Medium Multi-Role Combat Aircraft (MMRCA) was reduced from 126 to 36 Rafales, has no parallel in the history of defence procurement. The Air Force is since then scurrying for a new single-engine fighter for 'Make in India' to make up its depleted combat potential. Whether it is Yoga, *Swachh Bharat* or now the dream of New India, little of consequence happens in 'Mother India' without Modi's Midas touch.

As long as the higher defence organisation is not restructured, as recommended by a slew of reform committees, jointness, synergy and optimal value addition will be absent. So will accountability and political direction of the military. Not for nothing did K Subrahmanyam, the ultimate strategic thinker, state, "Politicians enjoy power without any responsibility; bureaucrats wield power without any accountability; and the military assumes responsibility without any direction".

After all, under the Government of India 1961 Order, the Defence Ministry was to act under Second Schedule of the Allocation of Business Rules and Transaction of Business Rules, which stipulated that the responsibility for the defence of India, including preparation for defence by the Armed Forces has been vested in the Defence Secretary.

Incredible !

The UK Defence Ministry Manual states : "Defence management has to be simpler, more cost-effective, contain clear allocation of responsibility, authority and accountability based on policy and strategy relating to Armed Forces, procurement, estates..."

Parrikar's pet projects were reinventing Defence Procurement Policy (DPP) and 'Make in India', where so far joked a General, only the logo has been assembled. The DPP is a voluminous and still confusing document despite several refits. The most elusive military figure in the country is missing since 1971 — the CDS. Indira Gandhi had reportedly told Field Marshal Sam Manekshaw that he would be the first to hold the CDS's baton.

The media had hounded Parrikar on the CDS since he first committed in 2015 at an *India Today* conclave to have one in place in three months. Everyone is still waiting. The *Economist* of 5 April 2013, one year after the Naresh Chandra Task Force had made its recommendations on the CDS, wrote: "Lip service is paid to cooperation and planning doctrine and operations. But this jointness is aspirational. India lacks a CDS of the kind most countries have because Government does not want single point of advice and service Chiefs do not wish to lose their autonomy".

If truth be told, there is no political will to appoint one in the face of bureaucratic stonewalling.

Still, Parrikar will be remembered for his one-liners: "To catch a terrorist, use a terrorist"; "Going to Pakistan is like going to hell". And after the surgical strikes: "I helped Army to see its strength (Hanuman power) and infused confidence in the soldier".

As Defence Minister, with one leg in Goa and the other in South Block, in the ultimate analysis, Parrikar's party's interests prevailed over national interest. After 27 months just as he learnt the ropes, he was posted back to Goa where the Chief Minister had lost his seat. Once again, the quintessential Jaitley was given additional charge of defence as if it was a part-time time job.

New Joint Doctrine for Indian Armed Forces



Released by Chairman of the Chiefs Of Staff Committee Admiral Sunil Lanba, in the presence of Air Chief Marshal B S Dhanoa and General Bipin Rawat on 25 April, the new *Joint Doctrine of Indian Armed Forces* directs that 'Strategic interests in regions along our northern, western and eastern borders and sensitivities along the Line of Control (with Pakistan) and Line of Actual Control (with China) are to be protected with effective deterrent capabilities.' The new *Joint Doctrine of Indian Armed Forces* states that 'India needs to systematically prepare for the "emerging triad" of space, cyberspace and special operations in support of military operations, even as it builds an integrated land-air-sea warfighting machinery, maintains credible nuclear deterrence and guards against unconventional threats.'

Also taking note of internal security challenges like the ongoing proxy war in J&K by an 'inimical adversary', insurgencies in northeast and left-wing extremism, the doctrine says a multifaceted approach backed by a robust intelligence network is needed to tackle them.

According to the doctrine 'initial steps' to develop a triad through the creation of the Defence Cyber Agency, Defence Space Agency and Special Operations Division are now underway. 'The triad makes integration essential. This flows from the vital necessity of cyber and space to 'plan' and the Special Forces to 'conduct' special operations.'

Air Force Commanders' Conference

Defence Minister Arun Jaitley inaugurated the biannual Air Force Commanders' Conference at Air Headquarters on 19 April 2017 and was briefed by Air Chief Marshal BS Dhanoa, Chief of the Air Staff on operational status of IAF, progress on infrastructural development and efforts made to enhance aircraft serviceability. Achievements during the recently conducted pan IAF and international exercises with "friendly foreign countries" were also covered by the CAS, who elaborated actions initiated for enhancing operational effectiveness and the future roadmap of IAF.

During the three-day conference, senior IAF commanders discussed issues pertaining to enhancement of combat effectiveness and development of human resources and infrastructure. To encourage indigenisation and enhance self-reliance in defence manufacturing an interactive session was held with delegations from HAL, BEL and other defence PSUs.

Acquisition of new fighters "to be fast-tracked"

Defence Minister Arun Jaitley has assured the Indian Air Force that the Government will be expediting the acquisition of new fighters and other critical systems as part of its modernisation programme. In his inaugural address at the IAF's Commanders' Conference, held in April 2017 at New Delhi, he made a reference to "uncertainties" in the region as well as on security challenges facing India in the midst of the rapidly changing geo-political situation.





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IAF preparedness for “short, sharp wars”

According to reports from New Delhi, “Air Chief Marshal BS Dhanoa has directed that the Indian Air Force commanders be prepared for short duration but intense wars of 10 days in case of Pakistan and 15 days with respect to China and also to maintain razor-sharp operational preparedness and enhanced combat effectiveness.” This was reportedly the key direction during the IAF Commanders’ Conference held in New Delhi during 19-21 April 2017. Accordingly, the Directorate of Air Staff Inspection (DASI) will ascertain preparedness of all operational units to keep personnel and aircraft combat-ready with stocked-up weapons, missiles and alive radar systems. Besides the essential IAF role of air defence and dominance, counter-air, strategic-air (including space) and counter-surface operations that form the elements of its air strategy, combat-enabling operations form the fourth pillar of air power.



“Aviation and Air Defence as priority”: COAS

Army Chief General Bipin Rawat has listed aviation and air defence as “high priority” for its modernisation plans. He was speaking at the biannual Army Commanders’ Conference in New Delhi in April 2017. The Army requires 259 light utility helicopters to replace the obsolescent Cheetah/Chetak fleet of helicopters based on the 1950s-design Alouette III and Lama and has also projected requirements for 114 HAL light combat helicopters. As for air



defence, the Army requires a three-tiered system, comprising the indigenous Akash SAM with a range of 25 km, the Israeli Spyder as the ‘low-level, quick reaction missile’ to neutralise hostile incoming targets up to 15 km away and air defence guns for close-in air defence, to within 4 km.

“Navy shortfalls will be tackled soon”: Arun Jaitley



Addressing the Naval Commanders’ Conference, Defence Minister Arun Jaitley has assured the Navy that “the government will increase resources to make good its shortfalls soon with due impetus, through appropriate defence procurement policies such as strategic partnership model which would be finalised soon.” Specific reference was made to the critical pending requirement for multi-role helicopters (MRH), conventional submarines and mine counter measure vessels (MCMVs).

“Defence manufacturing policy soon”

The government is at “advanced stages” of formulating a new policy to increase domestic defence manufacturing and so reduce dependence on imported hightech system. This was stated by Finance and Defence Minister Arun Jaitley on 28 April 2017: “India is the world’s largest arms importer, spending some 1.8 per cent of its GDP (gross domestic product) on defence. It imports about 70 per cent of defence equipment, a proposition which the government wants to change,” Jaitley said at an event organised by the industry body CII. “We are in the advanced stages of formulating a policy where we can ensure that instead of just being buyers, on the strength of technological and other tieups, India also becomes a manufacturing economy.” The government has reportedly projected the need to spend \$250 billion on weapons and military equipment over the next ten years.

Progress on the 'Strategic Partnership' policy

According to reliable sources in New Delhi, the Defence Minister Arun Jaitley has directed that the strategic partnership (SP) approach involving private industry in major defence manufacturing programmes "must be progressed without further procrastination." It is learnt that the Prime Minister's Office (PMO) has urged that this be carried out expeditiously. Such a major policy decision has remained dormant since the past eighteen months, even though informal discussions were held with shortlisted private companies during the ministership of Manohar Parrikar. It is learnt that senior private sector companies have been invited for formal discussions at the MoD and these include Larsen & Toubro, the Tata Group, Mahindra & Mahindra, Reliance Defence, Bharat Forge and the Adani Group.

These major Indian companies would be invited to work with international partners for the manufacture of new submarines, a naval utility helicopter, armoured fighting vehicles and most importantly, a new single-engine fighter.

IAI MRSAM LRSAMs for Indian armed forces

Israel Aerospace Industries (IAI) have finalised contracts with the Government of India worth almost \$2.0 billion. Considered to be the largest defence contract in Israel's Defence Industries' history,



IAI in conjunction with Indian partners will provide Barak 8 air and missile defence systems to the Indian Army (MRSAMs) and Navy (LRSAMs) for its new warships including the carrier INS *Vikrant*.

Major defence deals with Israel

According to speculative reports, Prime Minister Narendra Modi's forthcoming visit to Israel will include signing of major new defence deals, including the procurement of an air defence system for the Indian Navy. Israeli Ambassador Daniel Carmon stated that "India, Israel relations are big enough. The visit, when it takes place, will be very very important and will be one of the most important visits that Israel has witnessed in many many years. Israel has very good relations with India and the relationship has various facets including defence." Barak-8 air defence missile systems for the Navy, apart from procurement of Spike anti-tank missiles for the Indian Army are expected to be confirmed during this visit, which coincides with the establishment of 25 years of diplomatic relations between the two countries.

NITI Aayog's 15-year strategy for Defence



With its transformation from the erstwhile Planning Commission to NITI Aayog, whose CEO is Amitabh Kant (*see above*) "the Government of India has extended the realm of deliberations beyond traditional areas to cover aspects of defence and internal security", according to analysts. Interestingly, NITI Aayog in a meeting chaired by its vice-chairman Dr Arvind Panagariya and attended by India's top economists, had underlined the need to not only rapidly modernise India's military, but also considered whether the government is spending on weapons "without strategic purposes" keeping in view the "changed threat perceptions".

A recent NITI Aayog document titled *The Three Year Action Agenda: An Overview* states: "The allocation towards capital expenditure in defence will increase from around Rs 95,000 crore in 2015-16 to about Rs 1,72,000 crore by 2019-20, thereby increasing

its share of total expenditure from 5.3 per cent to 6.2 per cent. This is for increased purchase of equipment for the armed forces, keeping in mind the security considerations for the country.” Till now, the acquisition of weapon systems and equipment for India’s armed forces are based on the *Long Term Integrated Perspective Plan* (LTIPP), which directs the capability desired. A parliamentary panel had recently sought a cost-benefit analysis of the LTIPP. The report of the standing committee on defence said: “The (defence) ministry feels that there is no necessity for LTIPP. Therefore the committee desire that a cost benefit analysis of LTIPP should be carried out and they be informed of the findings”.

India’s military spend “fifth largest”

According to the latest report from the Stockholm International Peace Research Institute (SIPRI), India’s military expenditure grew by 8.5 per cent in 2016 to \$55.9 billion, making it the fifth largest spender in the world. The figures include expenditure on paramilitary forces of the Border Security Force, the Central Reserve Police Force, the Assam Rifles, the Indo-Tibetan Border Police and the Sashastra Seema Bal but do not include spending on military nuclear activities.

The top four in the list of military spenders in 2016 were the United States (\$611 billion), China (\$215 billion), Russia (\$69.2 billion) and Saudi Arabia (\$63.7 billion). In the top five, India had the highest percentage growth rate while spending by Saudi Arabia fell 30 per cent in 2016, despite its continued involvement in regional wars. Pakistan spent \$9.93 billion on its military.

Defence PSU Mergers and Acquisitions



Ministry of Finance has reportedly issued a formal Request for Proposal for listing a number of public sector undertakings (PSUs) under the defence ministry. These include Bharat Dynamics, Garden Reach Shipbuilders, MDS and Mishra Dhatu Nigam. Hindustan Aeronautics is also expected to make its market debut this year as will Cochin Shipyard, which is under the shipping ministry but also builds warships.

The government has planned a number of mergers and acquisitions (M&A) amongst PSUs. In his 2017-18 Union Budget speech, Finance Minister Arun Jaitley said there were “opportunities to strengthen” PSUs through consolidation or M&A and gave an example of the oil and gas sector. State-owned and listed construction company NBCC bought Hindustan Steelworks Construction as a subsidiary in April 2017. There are also plans to merge smaller PSUs in the construction space, such as Hindustan Prefab, Engineering Projects India, NPCC and HSCC, into the larger NBCC. Leading the process will be Mazagon Dock Shipbuilders (MDS) and the smaller Goa Shipyard Ltd (GSL) so as to ensure more attractive valuation for investors.

US NSA in India



US National Security Advisor HR McMaster met with PM Narendra Modi, NSA Ajit Doval and Foreign Secretary S Jaishankar during his visit to India in April 2017 “wherein both India and the US have reaffirmed their strategic partnership that involves not only growing defence ties but also shared perspectives of the region including a confluence on Afghanistan. Discussions covered the situation in Afghanistan, West Asia and North Korea.”

The leaders “exchanged views on how both countries can work together to effectively address the challenge of terrorism and to advance regional peace, security and stability”. A statement issued noted that the US reaffirmed India’s status as a “major defence partner” even as the two sides discussed a range of bilateral and regional issues, including their shared interests in increasing defence and counter-terrorism cooperation.

Canadian Defence Minister in India

During his week-long visit to India from 17 April, Canada’s Minister for National Defence Harjit Singh Sajjan had bilateral discussions with Indian Defence Minister Arun Jaitley on various defence and security co-operation issues. Sajjan was earlier given a Guard of Honour at South Block, which houses the Defence Ministry and also laid a wreath at Amar Jawan Jyoti at India Gate.

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During his visit, Sajjan addressed a special conclave organised by the ORF, where he gave a talk on 'Conflict Prevention and Peacekeeping in a Changing World' and answered a range of questions, including some controversial ones, with panache. He later visited Amritsar, Chandigarh and Mumbai, before continuing to Southeast Asian countries enroute Canada.

CAS visits AFS Agra, flies AWACS



Chief of the Air Staff Air Chief Marshal BS Dhanoa, visited Air Force Station Agra on 28 April 2017, and flew in an IAF AWACS (Airborne Warning and Control System) as part of the ongoing war gaming exercise of Western Air Command *Exercise Trishul*. Demonstrations included real time war scenarios in terms of large force engagement of air superiority fighters and other combat assets with the IAF, participating in dense electronic warfare environment.

Chinooks to be based at Chandigarh

Boeing CH-47F Chinook heavy-lift helicopters being acquired by the Indian Air Force are to be based at the Chandigarh Air Force Station, "for which new facilities are being established", according to reports. The GoI had signed a contract with the US in September 2015 for 15 CH-47 Chinook helicopters, with an



option for another four, the first of which are expected to arrive in 2018. There is a parallel contract for 22 Boeing AH-64 Apache attack helicopters.

"A certain number of Chinooks will be based in Chandigarh," a senior IAF officer said. "Two hangars and a maintenance bay along with associated technical and logistics facilities are to be set up here for the purpose." CH-47F Chinooks, with a payload capacity of around 10 tonnes will augment the IAF's vertical heavy-lift capability, which role was earlier fulfilled by the Soviet-era Mi-26 helicopters, also based at Chandigarh. The Chinooks will heli-lift artillery guns, vehicles, road construction and engineer equipment as well as troops and supplies to mountainous sectors particularly in the north and north-east.

'Valiants' resurrected with Su-30MKIs



No 221 Squadron, AF ('Valiants') presently commanded by Wg Cdr HS Luthra, were resurrected on 24 April 2017. Air Marshal C Hari Kumar AOC-in-C, Western Air Command IAF was chief guest for the occasion (*see above*). The 'Valiants' were formed as an offensive fighter squadron on 14 February 1963 at Barrackpore with Sqn Ldr N Chatrath as the first Commanding Officer. The

Squadron was over the next decades re-equipped with various fighter types including Vampires, Su-7s and the MiG-23BNs, distinguishing itself during the 1971 War and Kargil operations of 1999 (*the Squadron's history 'Valiant to the Last' has been published by the Society for Aerospace Studies*).

HAL Dhruv ALHs for Navy and Coast Guard



On 30 March 2017, the Government of India cleared a programme worth some Rs 8,000 crore for supply of 32 HAL Dhruv Advanced Light Helicopters for the Indian Navy and Indian Coast Guard, 16 each for both the services. A Performance Based Logistics (PBL) support for five years for ICG is the unique feature of this contract. According to T Suvarna Raju, CMD, HAL, "The PBL is an element of logistics support as an integrated, affordable, performance package designed to optimise system readiness and meet performance goals for the product through long-term support arrangements with clear lines of authority and responsibility".

HAL's performance in 2016-17



HAL has achieved its highest ever turnover, Rs 17,406 crore for the financial year ending 31 March 2017. "It is business as usual for us with the company doing well on expected lines. We also contributed around Rs 800 crore to the government



exchequer by way of interim dividend. This is in addition to Rs. 162 crore paid to government as dividend tax. The PBT stood at Rs.3,294 crore", stated T Suvarna Raju, CMD, HAL, who also expects 'Excellent' MoU rating from the government as it has met all the relevant parameters related to its performance. HAL's turnover for 2015-16 was Rs 16,736 crore and the PBT was at Rs.3,288 crore.

During FY 2016-17, HAL produced and delivered 12 Su-30MKI air dominance fighters (Phase-IV), 24 Dhruv ALHs, overhauled 197 aircraft / helicopters and 473 engines. The Company received orders worth Rs 21,000 crore that included 12 Do-228 aircraft for the Indian Navy, 32 ALH for the Indian Navy and the Coast Guard and AL-31FP engines for the Su-30MKI. The year also witnessed maiden flight of the HTT-40 and light utility aircraft (LUH) in addition to carriage trials of LCA with fixed mid-air refueling probe. 100 per cent rpm testing was carried out on the 25 KN turbofan engine (HTFE-25) and metal cutting began for the 1200kW turboshaft engine (HTSE 1200).

Rolls-Royce offer development of new engine

Rolls-Royce have reportedly offered development of a 'powerful' turbofan engine for future Indian fighters (read AMCA) which was subject of discussion during the recent visit to India of Sir Michael Fallon, UK Secretary of State for Defence. "Such a gas turbine engine, the very latest in technology, is being developed in collaboration between UK's Rolls-Royce and India's Defence Research and Development Organisation (DRDO) and Gas Turbine and Research Establishment (GTRE)," said Stephen Phipson, Head of Defence and Security Organisation, Department of International Trade, UK.

'SCOPE Meritorious Award' for HAL

HAL has been conferred the 'SCOPE Meritorious Award 2014-15' for Corporate Governance by the President of India Pranab Mukherjee, who presented the award to T Suvarna Raju, CMD-HAL at New Delhi on 11 April 2017. "I am happy to receive the prestigious award on behalf of HAL and its employees who are committed to the Company's growth and excellence. We



will continue to maintain and enhance the highest standards of Corporate Governance we have set for the organisation”, stated the Chairman of HAL. In the picture are T Suvarna Raju, CMD, HAL receiving the ‘SCOPE Meritorious Award 2014-15 for Corporate Governance’ from Pranab Mukherjee, President of India along with Anant G Geete, Minister of Heavy Industries & Public Enterprises (extreme left).

BEL achieves record turnover

Navratna Defence PSU Bharat Electronics Limited (BEL) reported a turnover of Rs.8,800 crore (provisional), a growth of about 17 per cent over the previous year’s turnover of Rs 7,522 crore. Some important projects executed during the year were the Akash weapon system, hand held thermal imager with laser range finder, 3D tactical control radar, weapon locating radar, upgraded L-70/40 AD guns, fire control systems, hull mounted sonar, radio relays, elements of integrated air command and control system, ship borne EW systems, and many more items.

As BEL’s Chairman & Managing Director MV Gowtama stated, “During the year, the company’s main focus has been on indigenisation to achieve self-reliance, capacity building & expansion and increased outsourcing to the SME sector. Also, BEL has been able to maintain good order acquisition this year. These efforts will enable BEL to continue to have sustained growth while effectively addressing future opportunities in defence business.”

Indian Navy test-fires Brahmos supersonic missile

The Indian Navy successfully test-fired a land-attack version of the Brahmos supersonic cruise missile on 21 April. The missile used INS and GPS/GLONASS/GAGAN guidance with terminal homing via a radar seeker in the missile’s nose. The missile was physically unchanged but utilised modified software to improve target discrimination on land, extended range via a lofted



flight profile, and incorporated a ‘steep dive’ attack in its terminal phase. The test was to validate the Indian Navy’s ability to employ the missile to strike inland targets, with earlier tests having been conducted against coastal land targets.

CG commissions high speed interceptor boat

A high speed interceptor boat (C 424) was commissioned by the Indian Coast Guard Region North East at Haldia on 25 April 2017, the ceremony performed by Inspector General KR Nautiyal, Coast Guard Commander North East. With this, Coast Guard assets in West Bengal now include 2 fast patrol vessels, 4 hovercraft, 2 interceptor boats, radar station and ACV forward operating base at Frazerganj. The 27-metre-long ship has been built at L&T Surat and achieves 45 knots of speed, and is equipped with latest navigational and communication equipment with a 12.7mm heavy machine gun as main armament. The ship is also fitted with night vision and infrared devices for day and night surveillance.

India, US and Japan plan joint naval exercises



India and the US plan to conduct naval exercises (*Malabar*) in the Bay of Bengal in July 2017, this time joined by Japan’s Maritime Self-Defence Force. A planning conference is to be held in the US to confirm the dates and list warships that will take part in the exercise, followed by a final planning conference in India. The exercises could include participation of aircraft carriers, nuclear-powered submarines and frontline warships, as well as P-8s of the Indian and US navies.

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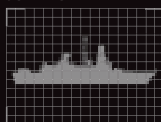
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In 2015, India and the US had formalised a significant pact to deepen bilateral defence cooperation including strengthening of military-to-military engagements, improved technical cooperation and bolstering overall strategic partnership till 2025. India and the USA are in the final stages of operationalising the Logistics Exchange Memorandum of Agreement (LEMOA) that sets down guidelines for the two militaries to share each other's assets and facilities for repair, maintenance, supplies and training on an equal-value exchange basis.

Triumph in BAE's M777 Howitzer programme



The Triumph Group, Inc. is to supply gun bodies for BAE Systems' M777 howitzer as part of the US Department of Defence contract, valued at \$15 million. Triumph Precision Components will machine, weld and assemble the gun body before shipping it to BAE for the cannon assembly. Deliveries will take place over the 30 months. "With their focus on quality and on-time delivery as their top priorities, we are pleased to welcome Triumph Precision Components back to the production supply chain as we lean forward to deliver our commitment on the M777 India programme," said Jimmy Dow, head of procurement for BAE Systems.

Tata Safari Storme for Indian Army

Tata Motors will supply 3,192 units of the Tata Safari Storme 4x4 to the Indian Armed Forces, under a new category of vehicles, GS800 (General Service 800). The Indian Ministry of



Defence (MOD) had earlier floated an RFP for vehicles with three basic criteria: minimum payload capacity of 800 kg; hard roofs and air conditioning. Developed indigenously, the Tata Safari Storme 4x4 has completed a total trial duration of fifteen months in various terrain across the country, demonstrating its performance in most demanding conditions with capabilities of coping with extreme on or off-road terrains. Tata Motors has so far supplied over 150,000 vehicles to the Indian armed forces.

Vistara expansion plans



Vistara, the full-service joint-venture of Tata Sons and Singapore Airlines which had commenced air services in January 2015 has completed induction of Airbus A320neo aircraft in its fleet, with the arrival of the 13th and the last such aircraft from Toulouse during October 2016.

The airline is planning major expansion both of its domestic series and launching international routes, for which it projects a requirement of 100 single-aisle aircraft and 40 widebodied types. The airline will begin formal evaluation in the course of 2017 and it is expected that various Airbus models are to be evaluated including the A350, as also Boeing's Dreamliner.

'Aerotropolis' planned in Assam

Minister of State for Civil Aviation Jayant Sinha has asked the Assam Chief Minister Sarbananda Sonowal to allocate some 2,000 acres to set up an aerotropolis in the state. "This would comprise an area whose layout, infrastructure and economy are based on an airport." As per the statement, the land should be not more than an hour's drive from Guwahati, close to the river Brahmaputra. "The aerotropolis will bring huge benefits to the region via better air connectivity and would be a good opportunity to establish air links with South East Asian countries. Mr Sonowal also requested Mr Sinha to launch Guwahati-Bangkok and Guwahati-Singapore direct flights to enhance tourism in the region.

RR to support Indian regional airliners

In connection with the regional air connectivity programme being promoted in India, President of Rolls-Royce India and South Asia, Kishore Jayaraman has stated that "We have interest in that segment of 50- 60 seater aircraft for which Rolls-Royce will offer appropriate power plants." However, he said that an Indian company such as the Tatas or Mahindras would need to establish an aircraft manufacturing facility for which based on market requirement, RR can supply engines 'Made in India'. In any event, Rolls-Royce India have been in dialogue with Hindustan Aeronautics (HAL) who have been planning to build the first 'Made in India' regional airliner by 2022 through the public private partnership (PPP) model. Rolls-Royce and HAL are already joint venture partners for various components of aircraft engines.

A320neos for Air India



Air India's first LEAP-1A-powered A320neo aircraft has gone into scheduled service. The airline has now taken delivery of three A320neos to date and is to induct 14 A320neos during 2017. "With the induction of more efficient LEAP-1A powered A320neos, Air India hopes to achieve improved economies of scale," stated Ashwani Lohani, C/MD of Air India. Air India has been a CFM customer since 2002, when the airline began operating Airbus A320ceo aircraft powered by CFM56-5B engines. Currently, the airline has a fleet of 51 aircraft in operation and has achieved more than 3.5 million flight hours with its CFM56 engines.

IndiGo continues to lead



IndiGo operated 900 flights on 7 April 2017, the highest ever by an Indian air carrier in the history of Indian civil aviation, highlighting IndiGo's position as the largest and fastest growing carrier with 131 Airbus aircraft connecting 44 destinations. Aditya Ghosh, President, IndiGo stated, "We at IndiGo are thrilled on having flown 900 daily flights for the first time I understand it's some kind of a record for civil aviation in India. Now the team is excited to reach the 1000 flight milestone."

Qatar Air's India venture

Qatar Airways along with Qatar's sovereign wealth fund will reportedly apply for an operating licence to start an airline in India even as it closes in on long-negotiated agreement to buy 49 per cent of Italy's Meridiana. According to Chief Executive Akbar al-Baker, its Indian carrier would be majority owned by Qatar Investment Authority (QIA), with Qatar Airways controlling a minority interest. Manufacturers Airbus, Boeing, Bombardier and Embraer would be invited to bid for orders from the Indian carrier. Qatar Airways has revealed plans to operate a domestic Indian carrier with around 100 jetliners.

Alliance Air to lease ATRs



Alliance Air, Air India's regional subsidiary, is to lease ten ATR-72 aircraft from Dubai Aerospace Enterprise (DAE) to expand its regional airliner fleet under the airline's *Connect India* programme and the government's regional connectivity scheme. The airline recently launched its first flight under the subsidised regional connectivity between Simla and Delhi and aims to complement its large aircraft operations to small cities with ATR turboprops.

IndiGo to purchase 50 ATR 72-600s

IndiGo has signed a term sheet with Avions de Transport Regional (ATR) for the purchase of 50 ATR 72-600 aircraft with the flexibility to reduce the number of aircraft deliveries based on “certain conditions.” This term sheet is subject to reaching a mutually satisfactory final purchase agreement with ATR and the engine manufacturer. Assuming that both the intended final purchase agreements are reached, IndiGo plans to launch its turboprop operations at the end of calendar 2017 and expects to induct up to 20 ATR aircraft by December 2018.

Honeywell selects Taj Air

Honeywell has selected Taj Air to provide support services to business aviation operators in India which will cover Honeywell propulsion engines and auxiliary power units. Taj Air is part of a network of leading maintenance service centres in India dedicated to providing full maintenance support to business jets, the company pioneering charter aviation in 1993 and starting its own maintenance department at Mumbai Airport in 2005.

Airbus H130s for Heritage Aviation



Heritage Aviation have acquired two new Airbus Helicopters' H130 to augment passenger transportation missions including heli-pilgrimage, aerial work and VIP transportation services. The two H130s will complement Heritage Aviation's existing fleet of two H125 helicopters which were inducted in 2015 from Airbus Helicopters. Both helicopters will be delivered with seven passenger seats and one of which will be fitted with cargo swing equipment to carry external load for aerial work missions.

Bell 429s for Tata Steel

The Tata Steel Group has purchased a second Bell 429 helicopter. As Sameer A Rehman, Bell Helicopter Managing Director for Asia Pacific stated, “The fleet of Bell Helicopter aircraft in India continues to grow as more and more customers come to depend on our performance and see the value in the flexibility provided by rotorcraft flight.” The technology in the Bell 429 includes a fully integrated glass cockpit, advanced drive system, best-in-class WAAS



navigation and IFR capability. “The Bell 429 has more cabin space than any other light twin helicopter, with flat flooring and seating for seven passengers and one pilot,” he added.

Navi Mumbai airport

On 21 April 2017, the Union Ministry of Environment and Forests (MoEF) granted the crucial stage II forest clearance for the Navi Mumbai International Airport (NMIA), paving the way for work on the ground such as cutting and levelling of Ulwehill, changing the course of the river and rehabilitation of projected-affected people (PAPs).

The government aims for the airport to be operational by end 2019. The City and Industrial Development Corporation (Cidco) of Maharashtra has offered 242 hectares of land in Sudhagad near Khopoli against acquisition of around 250 hectares of deemed forest area for the greenfield airport and has assured planting of mangroves three times that of the size in acquired area.

International airport in NOIDA

The Uttar Pradesh government continues to demand a new airport at Jewar, in the same district as NOIDA and only 100 km from the Delhi International Airport (DIAL). In 2001, Rajnath Singh, now the Union Home Minister and then UP chief minister, first proposed an airport there, as did Mayawati after she became CM in 2007. This did not make progress because of a clause in the agreement with GMR, preventing the establishment of a new airport within 150 km of IGIA. However, Union Minister of State for Civil Aviation Jayant Sinha has said, that “within a few years, we will be using all of the capacity (at Delhi). It is necessary for us to build a new airport”, while planning for increasing of capacity at the Delhi airport terminals would depend on improvement in airside capacity. “What we agree on is that airside movement will have a bearing on the building of a new terminal. With Delhi having three runways, it gives us significant capacity to increase the airside movement”. According to the minister, the improvement in airside capacity would lead to the addition of around 70 flights and thus, IGIA's passenger handling capacity would increase to around 90 million annually, from the current 62 mn, in the next two to three years.



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Rolls-Royce Service Delivery Centre



Rolls-Royce's Defence Service Delivery Centre (SDC) was inaugurated on 20 April at Bengaluru by Dominic McAllister, British Deputy High Commissioner, in the presence of Rolls-Royce executives. It is aimed at offering localised engineering support to improve frontline capability of Indian armed forces and HAL. "It is the first service delivery centre for Rolls-Royce outside the UK and the US and it is the first such centre in Asia," stated President-India and South Asia Kishore Jayaraman, adding that "this is definitely our next step in terms of our capability building."

The centre will provide services such as fleet management, services engineering and supply chain co-ordination. The aim is to deliver the optimum support possible to over 750 aircraft engines with the Indian Armed Forces, including the Adour which powers both the Hawk AJT and Jaguar DPSA, plus Gnome and Dart engines. It also provides coverage for AE2100 and AE3007 engines that power the C-130J and the Embraer 145, respectively.

Pratt & Whitney Customer Training Centre in Hyderabad

Pratt & Whitney's Customer Training Centre in Hyderabad has been certified by the DGCA, allowing the company to provide DGCA CAR147-approved training to aircraft engineers and technicians from Pratt & Whitney's airline customers in the region. This Pratt & Whitney training centre, established "to enhance the skills of the work force in India's aviation industry," is the third such Pratt & Whitney facility in the world. The training centre is now fully approved to offer DGCA-approved training sessions on V2500-A5 engines. It is expected to soon also offer courses on PW1100G-JM and other models from the PurePower Geared Turbofan (GTF) family of engines.

L&T and Hanwha Techwin partner in Tracked SP Gun Programme

Larsen & Toubro and Hanwha Techwin (HTW) of South Korea have teamed up on the 155mm/ 52 Cal Tracked Self Propelled (SP) Gun programme for the Indian Army. L&T was declared as the sole qualified bidder, post user evaluation trials, based on performance of the K9 Vajra-T, a self-propelled howitzer appropriately customised and fielded by L&T with HTW as the technology partner. The K9 Vajra-T gun is an enhanced version of HTW's K9 Thunder, to meet specific requirements of the Indian Army including in desert operations. Following the Indian government's 'Make in India' programme, L&T will manufacture K9 Vajra-T in India, having over 50 per cent indigenous content, and provide through life support from India.



Punj Lloyd and IWI in JV

On 4 May 2017, Punj Lloyd and its JV Partner, Israel Weapon Industries (IWI), inaugurated the country's first Private Sector Small Arms Manufacturing Plant at Malanpur in Madhya Pradesh. The joint venture company, Punj Lloyd Raksha Systems (PLR) will be manufacturing small arms for the Indian Defence Forces and also for export. Present on the occasion, Michel Ben-Baruch, Head of SIBAT, Israel Ministry of Defence said, "Israel's Ministry of Defence fully and wholeheartedly supports this cooperation and will continue to support the transfer of technology and information also in the future, for the betterment of improved advanced tools."



MTU and GRSE to assemble MTU Series 4000 engines

Garden Reach Shipbuilders & Engineers Ltd. (GRSE) will carry out the final assembly of MTU Series 4000 engines in India, both 12V and 16V 4000 M90 type engines which will be assembled at GRSE's Diesel Engine Plant in Ranchi. An option for the local production of parts in the future was also agreed. The engines have a rated power of 2,040 and 2,720 kW, respectively, and will be installed in various naval vessels built by GRSE. The agreement includes the transfer of MTU technology related to assembly, testing and painting. GRSE is one of India's leading shipyards and part of the Indian Ministry of Defence as a Defence Public Sector Unit (PSU).



APPOINTMENTS

Sanjay Mitra appointed Defence Secretary



The government named Road Transport and Highways Secretary Sanjay Mitra as the new Secretary for Defence on 10 June. Mitra will take over as the secretary after the present incumbent, G Mohan Kumar, completes his tenure. Sanjay Mitra, is a 1982 batch Indian Administrative Service (IAS) officer of the West Bengal cadre, and will have a fixed two-year tenure and also served a seven-year stint (November 2004 to July 2011) as a joint secretary in the Prime Minister's Office of Dr Manmohan Singh.

Dr Girish Deodhare is ADA Chief

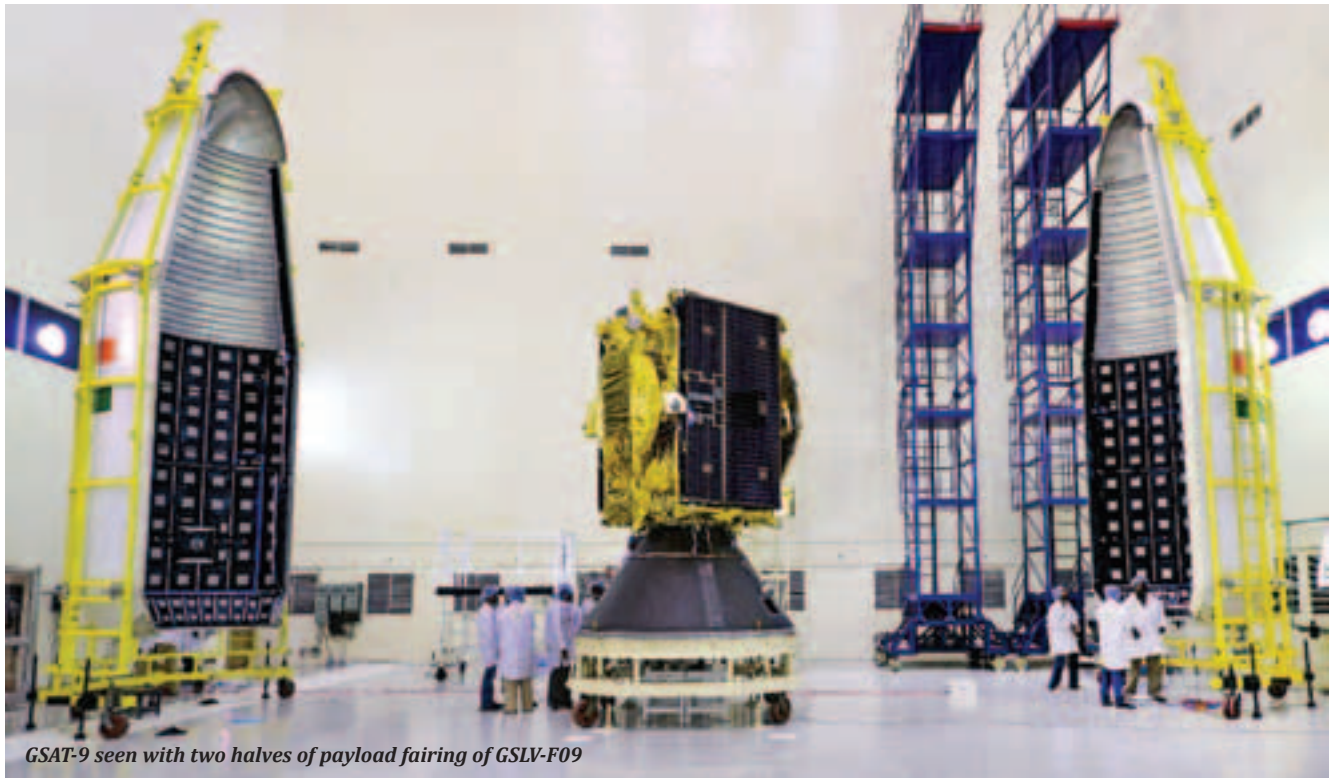
Dr Girish Shantaram Deodhare is the new Director of Aeronautical Development Agency (ADA). Taking over from Cmde Cadaba Devnath Balaji, who retired on 31 March 2017. Dr Deodhare was selected by a Search Committee headed by Dr VSR Arunachalam with Dr VK Aatre (both former heads of DRDO) and Air



Marshal Philip Rajkumar as its members. Earlier, Dr Deodhare was Associate Programme Director, New Programmes and Systems Engineering and Technology Director, Integrated Flight Control Systems, at ADA before taking charge of the organisation on 28 April 2017. He is expected to serve as Director for around six years, and is the 5th Director of ADA.

Dr Deodhare has a BTech (1984) in Electrical Engineering and M Tech (1986) in Control and Instrumentation, from IIT Bombay, holds a PhD (1990) in Control Theory from the University of Waterloo, Canada. Dr Deodhare had earlier worked with the Centre for Artificial Intelligence and Robotics (CAIR), a DRDO lab in Bangalore. He moved to ADA in 2007 as the Technology Director.

ISRO's GSLV launches 'South Asia Satellite'



GSAT-9 seen with two halves of payload fairing of GSLV-F09

India's Geosynchronous Satellite Launch Vehicle (GSLV-F09) launched the 2230 kg South Asia Satellite (GSAT-9) into its planned Geosynchronous Transfer Orbit (GTO) on 5 May 2017. This was its eleventh launch and took place from the second launch pad at the Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota, the spaceport of India, the fourth consecutive success achieved by GSLV carrying an indigenously developed Cryogenic Upper Stage. In its oval shaped GTO, the South Asia Satellite is now orbiting the Earth with a perigee (nearest point to earth) of 169 km and an apogee (farthest point to earth) of 36,105 km with an orbital inclination of 20.65 degrees with respect to the equator.

Few seconds before the launch countdown reached 'zero', the four liquid propellant strap-on motors of GSLV-F09, each carrying 42 tons of liquid propellants, were ignited. At count zero and after confirming the

normal performance of all the four strap-on motors, the 139 ton solid propellant first stage core motor was ignited and GSLV lifted off at 16:57 IST. The major phases of the flight occurred as scheduled. About

seventeen minutes after lift-off, the South Asia Satellite was successfully placed in GTO. Soon after separation from GSLV, the two solar arrays of the satellite were automatically deployed in quick



Hoisting of the GSLV-F09 second stage during vehicle integration

succession and the Master Control Facility (MCF) at Hassan in Karnataka assumed control of the satellite.

The 'South Asia Satellite' is a communication satellite built by ISRO to provide a variety of communication services over the South Asian region. For this, it is equipped with Ku-band transponders.

Following the successful launch, the Prime Minister of India, Narendra Modi congratulated ISRO and remarked that the day was historic for South Asia. The Prime Minister recalled that two years ago India made a promise to extend the advanced space technology for the cause of growth and prosperity of the people of South Asia and felt that the successful launch of South Asia Satellite fulfilled that.



Panoramic view of GSLV-F06 being moved to launch pad



A view of fully integrated GSLV-F09 from the top of vehicle assembly building

PM Modi called the launch of ISRO's GSLV-F09 as a "gift to SAARC nations." The Prime Minister further thanked the leaders of the neighbouring nations – Afghanistan President Ashraf Ghani, Bangladeshi Prime Minister Sheikh Hasina, Bhutanese Prime Minister Tshering Tobgay, President of Maldives Abdulla Yameen, Nepal Prime Minister Prachanda and Sri Lankan President Maithripala Sirisena – who joined the satellite launch event via video conferencing along with Modi. Pakistan was not a part of the project. "The support and presence of these leaders will add even more joy in the hearts and minds of our region. We are a united



The fully integrated GSLV-F06 carrying GSAT-9 at the second launch pad

family of South Asian countries, united in our pursuit of peace, progress and prosperity of our region and the entire humankind," he stated.

The move aimed at building stronger ties with South Asian countries though was criticised by Pakistan, who chose to stay away from the project. The neighbouring nation had earlier agreed to associate with the project and collaborate with India in building and designing the satellite but later, pulled out forcing India to change the name from *SAARC Satellite* to *South Asia Satellite*.

In the following days, the satellite orbit was raised from its present GTO to the final circular Geostationary Orbit (GSO) by firing the satellite's Liquid Apogee Motor (LAM) in stages. The 'South Asia Satellite' will be commissioned into service after the completion of orbit raising operations and the satellite's positioning in its designated slot in the GSO following in-orbit testing of its payloads.

(photos: ISRO)



And lift off!

BEL: to the core of Electro Optics

Night Vision Devices (NVDs) function by collecting tiny amounts of light, imperceptible to the human eye and amplifying it to a point we can easily see an image. NVDs gather ambient reflected light which emanates when starlight or moonlight falls on an object. The front lens receives the reflected light made of photons and sends it into an Image Intensifier Tube (II Tube). The light first falls on the photocathode tube that changes the photons into electrons. The electrons are then passed through a Micro Channel Plate (MCP), wherein their numbers are amplified through an electrical and chemical process. The electrons are then impinged against a phosphorus screen that changes the amplified electrons back into visible light (image), which is seen through the eyepiece. The image will be seen as a clear, green-hued, amplified, re-creation of the scene being observed.

The Night Vision and Electronic Sensors Directorate of the US Army has classified image intensifiers as Gen I, Gen II, Gen III, etc, based on the changes happening in manufacturing technologies. Generation I had a low gain and no MCP. Image intensifiers with MCP were subsequently developed and called Generation II. Both these had the Photo Cathode made of multi alkali material. Next came the image intensifiers which used GaAs as cathode material and a filmy layer coating on MCP, termed as Generation III. The definition of Generation IV would be an unfilmed MCP in the image intensifier. These are all technical issues, they tell how image intensifiers are produced, but not how they perform.

Innovations in photocathode technology have significantly reduced the tube's noise and increased the signal to noise ratio which is the undisputed characteristic to describe the low light level performance of an Image Intensifier Tube. The US government has recognised the fact that technology employed by different manufacturers varies, and itself makes little difference as long as an operator can see clearly at night.

The generation number identifies only how an image intensifier is manufactured. It does not say anything about the performance of a tube. By 2001, the United States federal government concluded that a tube's 'generation' was not a determining factor of a tube's global performance, and therefore the term was eliminated as a basis of export regulations. Consequently, the United States has based its export regulations not on the generation, but on a calculated factor called figure of merit (FOM). FOM is an abstract measure of image intensifier performance, derived from the number of line pairs per millimetre (resolution) multiplied by the tube's signal-to-noise ratio.

In India, there still is fascination about the generation of an Image Intensifier Tube. But one should realise that a reference to generation is nothing more than a marketing tool. Generation is not an assurance of performance or quality, according to M V Raja Sekhar, CTO (Electro Optics & Lasers), BEL.

Photonis, a world leader in night vision technologies, classifies its image intensifiers as Super Gen, Hyper Gen, XD-4, XR-5, etc, based on FOM. Night vision products of Photonis are in use at various NATO affiliates and are largely deployed worldwide.

The Indian Army has well understood the importance of FOM and all its recently released Request for Information (RFI)/Request for Proposals (RFP) for Night Vision Devices specifically mention the required FOM.

BEL Optronic Devices Ltd (BELOP), formerly BEL DELFT, a fully owned subsidiary of BEL started manufacturing of 2nd Generation Image Intensifiers in collaboration with and as a Joint Venture with BV DELFT Netherlands in 1994, as directed by the Ministry of Defence. This was aimed at



XD4 II Tube



Passive Night Sight for rocket launcher

having indigenous capability in India for such critical technologies. Subsequently, the technology was upgraded to Super Generation and Hyper Generation grade with in-house developments.

In 2012, the plant was upgraded to produce XD-4 II Tubes with technical know-how from Photonis, France, and about 40,000 tubes were supplied. The plant is presently being upgraded to XR-5 grade with capacity to produce more than 30,000 Image Intensifier Tubes per year. BEL also has plans to produce MCP indigenously with ToT from Photonis once the XR-5 is fully established.

The plant set up by BELOP is a state-of-the-art facility with a huge investment exceeding Rs 500 crores built on a total area of 13,608 sq mt and the built-up area of 8,650 sq mt. It has a workforce of about 130 permanent employees besides contract staff. There are more than 200 processes involved in the manufacture of XR-5 Image Intensifier Tubes and are controlled and monitored by highly qualified and competent engineers. BELOP has also established advanced test facilities to ensure quality and reliability of the II Tubes. BELOP is ISO 9001:2008 certified. India today is one of the few countries in the world possessing this highly guarded technology.



Courtesy: BEL

Passive night vision binocular

Saab Speak: “Everyone wins - when we Make in India”

India's vision for the defence and aerospace industry is clear: *Make in India* is the future, so that India can reduce import of defence equipment, become more self-sufficient and export more to other nations.

But what does *Make in India* really mean? We could look at *Make in India* as talking about manufacturing components and doing final integration of systems. We could talk about transferring old assembly lines from foreign countries, and putting together kits in India. But Sweden, and Saab, see partnerships quite differently.

When it comes to industrial cooperation in any partner country, Saab always chooses to expand the debate – so that both countries leverage their strengths and gain in skill development, design and engineering for future generations of systems, and technical education. Accordingly, Saab sees *Make in India* as a way to make India's defence industry the centre of the next technology revolution in Defence. This would mean looking at not just assembly, but at capability development at all levels. Including system and sub-system research, design and development; component and system manufacturing; quality & processes; integration; and finally, support and MRO – so India's armed forces don't have to look abroad to repair systems, but to get them back on the field and in the skies quickly.

Such capability development will ensure that in the coming decades, India is not simply licence producing foreign fighters and missile systems, but is designing and developing its own platforms that compete with the best in the world.

Saab's *Make in India* vision, for systems such as Gripen aircraft, Saab's AESA fighter radar and RBS 70 NG VSHORAD and BAMSE SRSAM missile systems, focuses on capability development from day one. It involves transfer of critical latest-generation technology to Indian industry. It involves working closely with Indian partner companies and suppliers at all levels, to design and develop the most advanced systems and sub-systems in India. It involves research and development partnerships

between Indian and Swedish universities. It involves introducing the world's most stringent yet proficient processes and quality systems that will enable India to design, develop, produce and support future defence platforms - that are then exported to the rest of the world.

Saab is not new to India. In 2016, it celebrated forty years of partnership with India's armed forces and industry, through a technology partnership with the Ordnance Factory Board on the Carl Gustaf System, a partnership that is still going very strong.

Saab today, works with some extremely proficient Indian companies such as Tech Mahindra on an R&D collaboration in

system, and on truck simulators for the Indian Army; and Bharat Forge, who is Saab's main partner in India for some of key missile programmes.

A growing partnership between Sweden and India is going to greatly benefit both countries – and help jointly develop the aerospace and defence systems that will set the global standard in the decades to come. Saab has an extensive blueprint prepared for customising, manufacturing and further developing the world's most advanced combat aircraft, the Gripen E, in India, with Indian companies. This will expand R&D initiatives in India, given the success of current design and



Hyderabad, doing development work on the Gripen E and the next generation Carl Gustaf system; with Aequus, with whom Saab have a joint venture that manufactures aerostructure assemblies in Belgaum; Mahindra Aerospace, CIM Tools and Tata Advanced Materials on commercial aerostructures components, Elcome Integrated Systems, on the National Automatic Identification System, which is protecting 7,500 km of India's coastline against unknown vessels; Ashok Leyland on trucks for Saab's BAMSE SRSAM missile

engineering collaborations in India. It aims to build the world-class air defence systems, the BAMSE SRSAM, the RBS 70 NG VSHORAD system and the pathbreaking anti-ship missile system – the RBS15 Mk3 – in India.

Saab wants to do all this in partnership with Indian industry.

Because Indo-Swedish Aerospace & Defence systems should be the best in the world.

That is why Saab will *Make in India*.

Courtesy: Saab

UDAN takes off with five airlines, on 128 routes, connecting 70 airports

The Regional Connectivity Scheme (RCS), also known as UDAN (*Ude Desh ka Aam Nagrik*, translated as 'let the nation's common man fly') will shortly get underway, with five airlines, including SpiceJet and Air India subsidiary Alliance Air, winning bids to operate on 128 routes. 70 airports, including 31 unserved and 12 under-served stations, will be connected under the new scheme, which will have fares for 50 per cent of seats on each flight capped at Rs 2,500 per seat per hour of travel. Air Odisha received the maximum number of UDAN routes at 50, followed by Air Deccan with 34 and Turbo Megha Airways with 18. Alliance Air will operate 15 routes, while SpiceJet won bids for 11.

Announcing the names of winning bidders and the routes, Civil Aviation Secretary RN Choubey said 128 routes are being awarded to five operators, which will fly 19- to 78-seat aircraft connecting airports spread across 20 states and union territories, including Punjab, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka, Tamil Nadu and Puducherry. Airports that will be connected under UDAN include Bhatinda, Shimla, Bilaspur, Neyveli, Cooch Behar, Nanded and Kadapa. Under the scheme, operators will be extended 'viability gap funding' — for which money is partly raised through a levy of up to Rs 8,500 on flights operating in major routes like Delhi and Mumbai. The viability gap amount is estimated to be "around Rs 205 crore per annum" for the operators chosen in the first round of bidding, said Choubey. When asked how the amount of Rs 205 crore could translate in terms of increased price on fliers on the major routes where the levy is imposed, Choubey said it would be around "Rs 50 per passenger. That is the 'ball park' figure, which is less than 1 per cent of the average ticket price."

Choubey also said that airports to be served under this round of UDAN

ROUTES UNDER UDAN

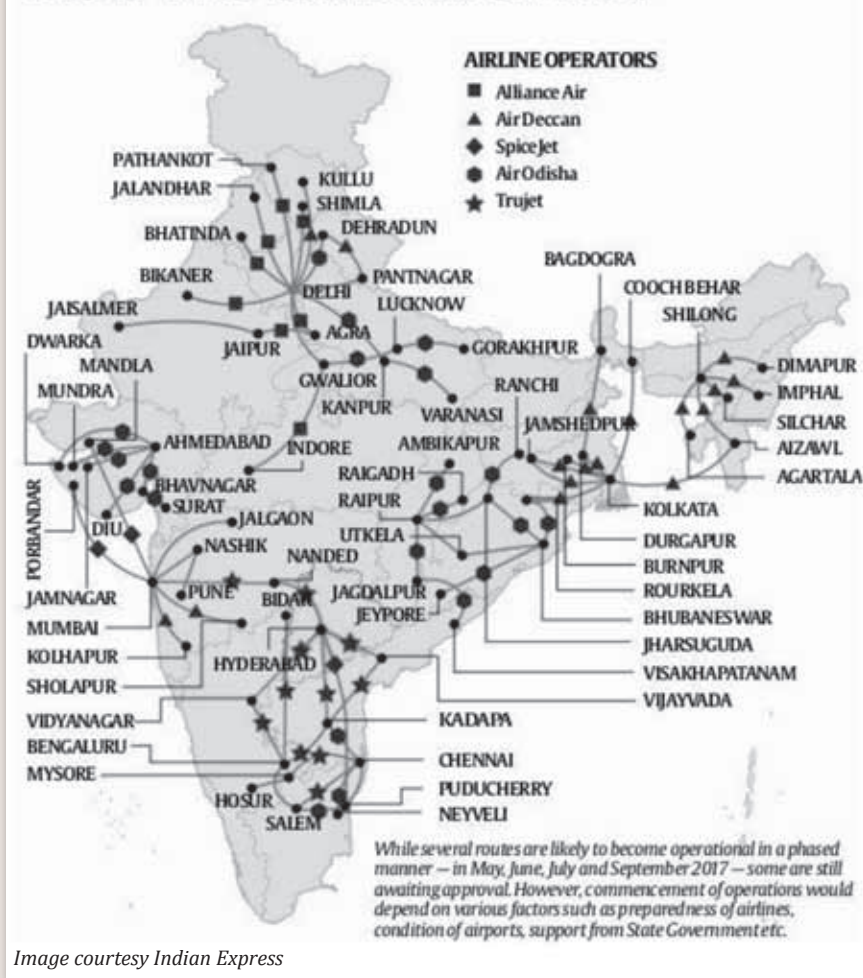


Image courtesy Indian Express

are in "ready to fly or nearly ready to fly conditions" and the next round of bidding would "commence shortly." Minister of State for Civil Aviation Jayant Sinha said criteria for selecting the winning bidders was based on the level of viability gap funding each of them sought per seat. The viability gap funding would be in place for three years for the airlines concerned from the date of starting operations in a particular UDAN route. The scheme also provides for various benefits including no

airport charges and three-year exclusivity on the routes.

However, SpiceJet CMD Ajay Singh said that the airline would not be availing viability gap funding, while Amber Dubey, Partner and Head of Aerospace and Defence at KPMG in India pointed out that timely payment of viability gap funding would be key to sustainable operations. "AAI must install fool-proof monitoring mechanism to ensure no undue delays happen," he said.

A Second Chance



From Vayudoot to UDAN, 25 Years on

One of Vayudoot's first Dornier 228s ...

When the first bold moves were made to introduce regional air connectivity in India over a quarter century back, the then Government logically relied on the professional background and experience of DGCA, Indian Airlines and Air India to ensure that the special entity formed for the purpose (eventually *Vayudoot*) would be suitably managed. Unfortunately, there was some indifference or even prejudice amongst these organisation, mostly owing to gross ignorance of realities. It is therefore appropriate to review the lessons learnt which will impact on the success – or otherwise – of the latest efforts to promote regional air connectivity in India, alias UDAN.

The *raison-de-etre* of India's first true third level or commuter airline, Vayudoot was not really appreciated 25 years back, thus its inevitable financial losses which became the main reason for its untimely closure. Laying the blame on the logically selected regional airliner and all the other arguments



... and an ATR-72 of Alliance Air (Air India)

voiced in respect of the airline or its Dornier 228 fleet, were peripheral and used only to camouflage what was gross mismanagement.

To understand the situation vis-a-vis Vayudoot and its Dornier regional airliners, it is necessary to go back in time to the years before this third-level airline was formed

and the Dornier 228 aircraft selected by an experts' committee appointed by the Government of India. It is also true that every time an aircraft from Hindustan Aeronautics Limited is manufactured, then that specific aircraft becomes the target of general criticism, and this too was the fate

of HAL's Dornier 228 regional transport aircraft programme.

But going back some decades earlier, in the early 1960s, HAL had initiated manufacture of the Avro (later Hawker Siddeley and still later British Aerospace) 748, in technical collaboration with the British aircraft and its engine manufacturers. These aircraft were essentially acquired and subsequently manufactured to meet requirements of the Indian Air Force. In view of the need for a similar aircraft type for Indian Airlines, the government determined that the same Avro 748, delivered from HAL should fulfil this need which precluded further purchases of the Dutch-origin Fokker F-27s. In order to help in the sale of HS 748s to Indian Airlines, these were actually subsidised by the Government such as to make the HAL delivery price equal to that of the imported F-27.

It is a fact that Avro 748 deliveries from HAL were not taken kindly by either Indian Airlines or the private-sector suppliers of ancillary equipment and services for reasons not necessary to amplify upon here. Compounding this was an appalling lack of product support by HAL and its "inability" to appreciate economic practices

of the civilian market, which soon gave Indian Airlines, and others, the excuse they needed – and used – to obstruct further deliveries of the Avro 748 from HAL. In this devious game, the Indian aviation industry particularly and the country generally, become the loser.

In stark contrast were the examples of Indonesia and Brazil, whose respective Governments had decreed that their national airlines would procure civil airliners only from the national aeronautical industry. IPTN-Nuritania and Embraer thus flourished, with the Indonesian and Brazilian national airlines operating NC-212s and CN-235s with the former and Banderainite and Brasilia with the latter.

Notwithstanding these obstructions, originating from various sources, HAL's HS 748 production programme was not altogether unsuccessful. If nothing else, it was a catalyst in developing self-confidence within HAL, sufficient for it to initiate a number of design studies for the indigenous development of turboprop transport aircraft (the 24-seater HAC-33 being a case in point). By the mid-70s, HAL was well positioned to launch and actively pursue this regional-airliner design

and development programme. The fact that this metamorphosed into the HAL-Dornier 228 (and the future 328) is another story.

At about that time (the mid '70s), Indian Airlines was operating a mixture of jets and turboprops in its fleet, with a dual fares structure (one for jets and a lower one for turboprops), apart from the Eastern Sector where the fares were even lower, but incurring heavy losses on its turboprop network. The jet fleet (Boeing 737s and Caravelles) actually cross-subsidised most of the turboprop operations.

The mid-70s were also a period of turbulence for Indian Airlines. Industrial disputes compounded by management ineptitude and rivalry for succession invited political interference, which in turn led to the irrevocable weakening of long established institutions, within and without the Airline.

Political instability, the presence of extra constitutional centres of power, the break-down of institutions took place in Indian civil air transport from 1975-76 onwards. Vayudoot was created under such circumstances and with its launch in 1981, Indian Airlines was helped to 'painlessly' get rid of the loss-generating part of its



The 19-seater Dornier 228 was followed by the 34-seater Dornier 328

operations. Henceforth, the financial year ending would bring few sleepless nights to the financial managers of Indian Airlines.

Another act in this play was being enacted elsewhere. A group of well meaning professionals, with hopelessly inadequate resources at their disposal, were examining (demi-officially) the third-level air transport market in India, its extent and its requirement of “small passenger aircraft.” With the limited data at their disposal, however well-intended, this study unfortunately soon became the point of reference for all future work on the subject of third-level air links in India.

About this time, the defence and para-military forces too were examining their requirement of light transport aircraft

Menon, and so on) but then procrastinated. The objective was that a common aircraft type be chosen to suit the requirements of the various agencies, so that the cumulative numbers of aircraft thus determined should be such as to launch an economically viable manufacturing programme in India.

The Menon Committee was the last of these many Committees, and included senior officers from the Airlines, Air Force and Industry. The consensus choice was for the German Dornier 228, selected from a long list of contenders, which included the Canadian Twin Otter, the Spanish CASA 212, the American Beech 1900 and the British Shorts Skyvan. The Committee ruled that of the competing aircraft, the Dornier 228 came closest to

fulfilling the specified roles, as laid down by the various potential operators. The choice was to be optimal for the cumulative demand. Moreover, Dornier’s technical and commercial terms of collaboration for manufacture and comprehensive technology transfer were “superior than those offered by the competition”. It was also recognised, and justifiably, that in order to encourage the growth of the indigenous aircraft industry there should be potential for further development of a 30+ seater and entry into the export market.

To put the matter in its proper perspective, from a production run of some 150 units which were contracted for, the delivery programme for the civil market (Vayudoot and others) was less



Vayudoot Dornier 228s pioneered air services to mountains regions, such as Simla (above)....

for a number of different roles, which varied from personnel transport and light logistics support for the Indian Air Force to long endurance maritime surveillance by the Coast Guard, to a multi-role Naval warfare capability for the Indian Navy. The National Airports Authority wanted a suitable platform for calibration of ground nav-aids etc., the Directorate of Science and Technology for weather related research, the National Remote Sensing Agency for its surveys and the ONGC for executive transportation.

The Government was aware of these demands for a national light transport aircraft and set up committee after committee (Sinha, Gidwani, Zaheer,



... and Agatti in the Island archipelago of Lakshadweep (below)

than a dozen aircraft, with a further score or more possible. The additional deliveries earmarked for the civil market were intended to encourage HAL to develop its civil marketing expertise and infrastructure.

Since many believed that the woes of Vayudoot were partially due to either the “poor despatch reliability” of the Dornier 228 aircraft or to its “bad economic performance” or both, these aspects needed to be looked into before Vayudoot’s performance itself is examined.

There were at the time well over two hundred Dornier 228 aircraft already in worldwide service with some 74 operations in 17 countries. The average global technical despatch reliability of this aircraft was 99.7 per cent with some operators achieving 100 per cent. In contrast, Vayudoot’s despatch reliability achieved never exceeded 97 per cent or thereabouts. Nevertheless, even while the Vayudoot on-time performance was poor in comparison, it still managed to achieve one of the highest utilisations in the world, some 207 hours per month on its

Dornier 228 aircraft ! The reasons for the below-average performance of the Dornier 228 in Vayudoot’s fleet were therefore to be found not with the aircraft but elsewhere - perhaps with the manner Vayudoot which about conducting its business. Even Druk Air of Bhutan had performed as well or better than the world average and the Indian Coast Guard had achieved much better results.

The original purpose for which Vayudoot was formed (at least as far as the Government of India was concerned) was to airlink nationally strategic areas with the rest of the country and to provide adequate transportation in those areas where other modes of transport were inadequate and difficult. With Vayudoot performing a socio-strategic role, commercialism or profitability played little or no role in the original plans for India’s third-level air transportation. Even though the original plan did not expect ‘commercialism’ from Vayudoot, this was not intended to be a license for gross mismanagement. Unfortunately, in an environment which became increasingly

casual on professionalism and soft towards individual self-interest, this very latitude was made use of by a coterie, consisting of the then Vayudoot management, the bureaucracy and some politicians, at cost of the future.

So, when a myriad of difficulties began to raise their heads and costs to the national exchequer began to mount, scapegoats were invented. First, it was the aged fleet of the HS (Avro) 748 and Fokker F.27s then the “uneconomic” Dornier 228 aircraft, then it was Indian Airlines and its exorbitant maintenance charges and finally, the very concept of this bold enterprise !

The tortuous tale of Vayudoot did not end there, and the commuter airline was forced to limp along as best as it could much like Delhi Transport Corporation! The limited size of Vayudoot was hopelessly inadequate for the genius of the powers-that were and so, according to the dictat, Vayudoot was to expand by co-partnering with Air India on its domestic operations. The die was cast !

Druk Air of Bhutan was founded on the Dornier 228, seen here at Paro airport



Rashid Jang, then Planning Manager with Indian Airlines wrote on the original imperatives for Vayudoot



The original imperatives for creating Vayudoot were essentially strategic in nature, with an element of social benefit thrown in for good measure. The north-eastern area of the country, which is mountainous and heavily wooded, lacked satisfactory surface transportation. This lack of transport meant political, social and administrative isolation, as also negligible or marginal potential for a balanced economic development of the region. In short, the area, as a whole, was likely to be left behind the rest of the country in various fields. Additionally, isolation from the mainstream was impeding the process of psychological integration with the rest of the country.

To redress this situation through development of conventional surface transport systems is a long drawn out process and time was of the essence : therefore, the recourse to air linking, the cost of which was obviously of secondary importance. It was more to provide faster communication and improve accessibility to the region for a faster pace of development. The benefits were, therefore, to be seen in the broader perspectives of social economic and political terms, rather than straight profit or loss within the air transport sector.

Air linking of points in the north-east were, certainly the high-water marks of Vayudoot's achievements. This momentum needed to be directed towards deeper penetration, in the NE region specifically, and elsewhere, where the problems were similar. With inherent limitation of resources, particularly those of funds and technical manpower any dissipation of these on the spectacular was to be discouraged.

It was clear that Vayudoot was expected to go through three stages of development towards its maturity:

- ✧ fulfilling of strategic needs,
- ✧ meeting of social obligation, and finally
- ✧ attaining commercial viability.

The time to maturity would depend upon the extent of funds invested, the speed of investments, as also on the concurrent growth of economic activity in the regions served. However, as specific operations and routes commercially matured, more areas would be opened to air transportation. Thus, at any given time, the financial health of Vayudoot would be impacted by government policy in this regard, and determined by the mix of strategic, social or commercial mix of operations.

Therefore, in the context of resource constraints, the managers of Vayudoot should really have planned carefully to

meet designated objectives, investments carefully scheduled as also cost of operations kept to a minimum. The strategic requirement, in particular, and social needs in their early stages of development, both required more flight intensive operations, rather than passenger intensive. The need was for a low-cost, robust and free-of-frills aircraft, economic to operate on aircraft-mile basis, so that for a given expenditure market coverage was maximised.

The employment of Vayudoot as a catalyst in the process of development of isolated regions and communities, as also linking them more closely with the national mainstream, obviously needed to be supported by innovative accounting methods and procedures. This was very important, since during the nascent stage, certainly, and may be for very long, Vayudoot could continue to remain financially a marginal operator, and methods of allocating 'shadow value' to these needed to be developed.

Alas, it was not to be. Vayudoot came to an ignominious end within the decade but hopefully there is an afterlife and UDAN could be given that second chance.

**Based on the original article
Vayu's Issue III/1992**

Case Study



The Indian Scene, circa 1975

Typical scene at metro airports in the early years of Indian Airlines : DC-4 on the tarmac as DC-3 takes off

So, what has changed? Vayu Aerospace Review flies readers back to the early seventies on India's endeavour to start regional air connectivity which rationale was understood and promoted for nearly a decade before Vayudoot, India's regional or third-level airline, came into being in January 1981. Successive ministers for civil aviation had periodically announced that the government was studying the possibility of establishing such air services to link hitherto unconnected points, particularly in the North-East, that various options as to the kind of air carrier were being examined

and that various suitable aircraft types were being evaluated. In fact, it was after the fifth successive committee's report that such an airline took formal shape, assumed a name and began air services, albeit with borrowed feathers so to speak. It was upto the sixth committee to select the most efficient and cost-effective aircraft to match the nation's objectives.

Read on : As stated in Indian Airlines' Annual Report for 1974-75, the Corporation achieved the transformation of a budgeted loss of Rs 16.5 crores to a surplus of Rs 1.01 crores basically because it revised the

route system that resulted in *the closure of 16 out of 70 stations* (emphasis added) and re-deployed its aircraft to sectors where the demand, and hence the earning potential, was greater. Hence, the overall load factor of 66.5% was exceeded by two points, closure of the sixteen stations and augmentation of capacity on routes with higher traffic potential resulting in a net reduction of Available Tonne Kilometres by 7.1% but an increase in Operating Revenue per ATKm. by 15.3%. Yet, as the Report continued, "the Corporation was not guided only by the profit motive and continued to operate



Douglas DC-4 Skymaster of Indian Airlines



Douglas DC-3 Dakota of Indian Airlines

certain uneconomic routes as an obligation to provide air services in the country as a whole and for regional development and the growth of tourism". Notwithstanding, sixteen stations were actually closed down and Indian Airlines refused requests for operation of new services or to modify existing routes when the change would increase its financial burden.

Now, who decides on the overall interests of the nation? The annual balance sheet of a public sector undertaking? The preamble continued: "The nation is striving to accelerate its economic development and de-centralisation of industrial and commercial concentrations is an avowed aim. Transport and communications are vital factors not the least because they support such growth but are an obvious link is the great task of national integration."

Government of the day had decreed that "If the state-owned airline is unable to justify operations to remote or inaccessible parts because of economic considerations which directly relate to existing overheads, a solution can be found in allowing private or quasi-Government organisations to take over this responsibility."

There were many private carriers and State Governments both willing and capable of providing such services efficiently and safely. Recall the efforts of *Jamair* in the North and East, *Safari* in the West and *The Hindu* in the South during Indian Airlines four-month 'lock out'. And these services were willingly extended, albeit under the constraints of operating elderly and uneconomic DC-3 Dakotas. "For many years now these and other potential operators have applied for permits to serve stations not on the IA network. All these have, unhappily, come to naught not because the proposals were unattractive, but because the powers that were remained

indifferent or constantly changed their policies to suit the hour, or simply, disliked taking a decision." Meanwhile, the nation was denied this input to economic gain.

A New Year Gift

A new year gift on 2 January 1976 came in the form of a public statement by the then Minister for Civil Aviation announcing that the Government had offered nine select routes for operation of passenger services by private airlines. Proposals were invited and it was hoped that a final decision would be taken within the year. Also mentioned was that "a search for a suitable third-level aircraft for operating on the feeder and sub-feeder routes, was in progress." Also that, Indian Airlines would not need to examine such aircraft, leaving the choice to the party involved and whose consideration would be dependent upon the infrastructure of the area selected and not the least, upon guaranteed Government promotional policies like subsidies and fuel tariff reductions.

For some years too, various official bodies and institutions had conducted surveys and examined the requirements for third-level air services in the country. Then, in 1974 the Ministry of Defence commissioned a study on the feasibility of developing and manufacturing a transport aircraft indigenously to meet the requirement of both civil and military needs. Traffic forecasting studies were a preliminary necessity and this went into great depth in surveying the pattern of transportation – and latent potential. The Study Group, composed of members from the DGCA, the Air Force, Indian Airlines, Department of Defence Production and Hindustan Aeronautics, submitted its recommendations in June 1976. The conclusion was that a third-level air service

network was *essential, viable and practical*. "The services must, however, be directly stimulated by pragmatic promotional policies and the industry could be put on its feet during the formative stages by necessary subsidies. The Indian aeronautical industry has the expertise and means to design and develop a suitable aircraft to meet the requirement."

The Rationale for Regional Air Services in India

The study continued: "In 1974, India has a population of near 600 million (*1.2 billion in 2017*!) and while eighty percent are scattered amongst 576,000 villages, nearly 110 million live in 2650 cities and towns. The land mass measures 3,287,782 sq km and there are rail links covering over 60,000 kilometres and surfaced roads totalling 1,150,000 kilometres. Much movement takes place by rail (estimated at 7.5 million passengers per day) and road and the lack of air links makes any study of potential volume of air travellers necessarily speculative, but the absence of air traffic at the third level at present cannot obviously be construed as lack of traffic potential."

"Still, it would be necessary to lay down certain criteria and parameters in order to identify the potential that remains untapped. Any proposed network should take the following into consideration: the basic element would be cities and towns with existing airfields and these include those on Indian Airlines network all towns and cities with a population over 80,000 should be included intercity distances could be prescribed by a lower bound of 50 km and upper bound of 500 km, the former being assumed as the cut off distance below which air travel is unlikely or unnecessary except where surface transport is non-



Fokker F-27 of Indian Airlines

existent such as in the hilly tracts of north-eastern India.

A study by the DGCA reportedly established the existence of a definite potential of 92 sectors but, taking the above considerations into view, the list could cover 172 cities with an associated set of over 2,300 city-pair connections.

There were other factors, of course, like population, habits, income levels, growth of industrial production, affinity parameters, inter modal travel time differentials between the city-pairs and a host of others. Owing to the near complete absence of historical statistical data relating to third level air traffic, no extrapolation of past data into the future is possible especially when a quantum jump could be natural when the numerous virgin city-pair connections at the 3rd level are considered.

Perhaps the closest correlation that could be employed would be through a time series analysis of the distribution of passenger traffic on the railways (Air Conditioned and First Class modes) and by private automobiles, taxis, or deluxe buses on highways between city-pairs. Market surveys have been carried out by the National Council of Applied Economic Research (NCAER) in Maharashtra, at this State Governments request, and a limited survey was conducted by Karnataka and these have indicated the existence of very high traffic potential on the chosen routes — but not operated by Indian Airlines.

The Tentative Start

Management of the then Indian Airlines had often expressed that many of their regional routes were “uneconomic and it may thus be profitable for IA to shed most of these

and concentrate on the trunk routes. The regional routes so shed could then form the basis of the proposed nation wide third level air network to link the far flung corners of the country and these may be operated by several agencies, in both public and private sectors.”

This was rational and would bring about several benefits. Firstly, increased profitability for Indian Airlines, secondly, and more important in the national context, the establishment of fast air links to remote or inaccessible parts, fostering accelerated economic development and enhancing national integration. The fact that rapid communications established and available would mean a relief of industrial and commercial congestion, presently centralised. Large numbers of aircraft plying between outlying areas would have a direct fallout in terms of an enlarged sophisticated technical base; a host of manufacturing and overhauling facilities would spring up all over the country to support such aeronautical hardware and this would stimulate self-reliance in this field.

Finally, and not the least important, such a network of air services and maintained airfields, would result in an enhanced degree of national security, for both external and internal contingencies making it practical to rapidly deploy armed forces in far flung or hitherto inaccessible areas. “It is hoped that the early eighties will witness the establishment of third-level air services, linking scores of towns throughout the country. Firstly, reactivating the stations ignored by Indian Airlines and, increasingly, bringing a hundred new points on the air map of the nation.”

Thus the advent of Vayudoot

Described variously as the fastest growing air carrier and earning the sobriquet of the world’s “biggest little airline”, the year 1986-87 was termed as one of mighty expansion for Vayudoot but also one which required a sober period of consolidation thereafter. Undoubtedly the world’s most widely operating commuter airline, Vayudoot came in to its own with receipt of the first Dornier 228 regional airliner in December 1984. Within the first few months of 1985, the third-level airline had added 14 additional stations to its network, taking the total served to over 30. By the end of 1985, Vayudoot was operating to 50 stations in all four geographic regions of India and with its fleet of five German-supplied Dornier 228s augmented by another five assembled by HAL, plus transfer of seven HAL-BAe 748s and F.27s from Indian Airlines, the carrier continued to add new stations throughout 1986 and early 1987 to reach the figure of 87 points served by the autumn of 1987.

Deliberations and Decisions

But, before embarking on the next expansion period, “it would be necessary to review the rationale and imperatives which laid the foundations for India’s third-level or commuter or regional airline.”

The rationale for feeder air links within the vast country was understood and promoted for nearly a decade before Vayudoot, India’s regional or third-level airline, came into being in January 1981. Successive ministers for civil aviation had periodically announced that the government was studying the possibility of establishing such air services to link hitherto unconnected

points, particularly in the north-east; that various options as to the kind of air carrier were being examined and that various suitable aircraft types were being evaluated.

In fact, it was after the fifth successive committee's report that such an airline took formal shape, assumed a name and began air services, albeit with borrowed feathers so to speak. It was upto the sixth committee to select the most efficient and cost-effective aircraft to match the nation's objectives.

Most of the deliberations took place through the seventies. In 1974, the government had set up a multi-discipline committee under Vivek Sinha (later Additional Secretary DRDO) to not only examine the requirement for such feeder air links but to identify places to be air-connected, quantify the size, type and number of aircraft required and, finally, determine whether the indigenous aircraft industry was capable of developing and producing such an aircraft in the numbers required.

The answers were clear: the country required such regional air links for social, economic and strategic reasons, over 50 points throughout the sub-continent would eventually justify air services and considering the multi-purpose employment of a 18 to 20-seater light transport aircraft, well over 100 aircraft would be needed. Hindustan Aeronautics Limited had the expertise and resources to undertake this national task.

Even as the Design and Development Bureau of HAL, under the direction of then Director D&D SC Das, started preliminary design studies for such an aircraft, eventually labelled the HAC-33 in 1976, the domestic carrier Indian Airlines nominated their Planning Manager, JK Chaudhuri, in 1977, to initiate an examination of third-level traffic potential; identify city-pairs to be connected, frequency of operation and the likely type of aircraft that could fulfil the needs. Both reports were positive in their conclusion, and became the springboard for a simultaneous approach towards the objectives of creating third-level air links and having an indigenous aircraft to serve them.

In May 1978, Hindustan Aeronautics Ltd and Dornier of West Germany, signed a Memorandum of Understanding to design, develop and manufacture a light transport aircraft incorporating the 'wing of new technology' evolved in Germany, with potential to grow from the optimum 19-seater category to a 24-seater

and eventually to a 30-plus-seater class. Dornier were a highly respected company with roots in aviation history and having at the time a similar study for 19-24 seat light transport aircraft on their drawing boards. A large number of design engineers from HAL were nominated for joint studies with Dornier at Friedrichshafen on the Lake of Constance in Southern Germany in mid-1978 and positive recommendations were framed for the Government's consideration.

Simultaneously in 1978, India's Civil Aviation Ministry constituted the Gidwani Committee to examine the manner in which the proposed third-level operations could be started bearing in mind the requirement of different regions, potential traffic and priorities, and whether Indian Airlines, or a subsidiary or a separate public sector corporation or a joint sector corporation should be entrusted with the responsibility. Further, the Gidwani Committee was to review the minimum developmental work required at airfields to support such third-level air operations and also shortlist the most suitable aircraft types from the technical and economic points of view. Finally, the Committee was to project estimated financial results and whether the third-level operations could be subsidised by grants from the government until such time as they became self-sustaining.

As there was little coordination with HAL at the time, the Committee restricted itself to examining those small passenger aircraft as were available in the world market and, in fact, the DHC-6 Twin Otter from Canada, the N-24 Nomad from Australia and later, the Short Skyvan from Britain were evaluated in typical terrain and conditions particularly in the North-East. "The results were not spectacular". In its view apart, the high-level National Transportation Committee proclaimed that third-level air services would not be considered as priority except in the difficult North-Eastern area. This view was not necessarily unanimous.

However, at the government level, there was still no coordinated effort with HAL which continued on studies of their own, taking a far more broad view on the requirement for such category of light transport aircraft, with a number of defence services, as well as various Public Sector Undertakings in need of a similar class of aircraft by the mid-80s. These included

the Indian Air Force, the Navy, the Coast Guard and para-military services.

Actually, the Ministry of Civil Aviation constituted two more Committees in 1979-80 with nearly the same terms of reference as had earlier been entrusted to Gidwani: the Zaheer Committee, followed by the Braganza Committee, were tasked to make recommendations regarding the nature, type and size of aircraft, to identify the stations, other than the North-Eastern ones, which should be covered by third-level air services, assess the number of aircraft required to serve the stations and to recommend the airfield infrastructure required so that the entire country could be covered in phases over three years. The Braganza Committee submitted its report late in 1980.

Clearly, this too, fell short of what the government desired: a larger view had to be taken, bringing in the requirements not only of the proposed third-level airline, but also of the multifarious operators of such category of light transport aircraft in the country and, vitally, the involvement of India's aircraft industry in such a programme.

Thus, in early 1981, the Menon Committee was constituted, with members nominated from the airlines, (Capt Kamni Chadha, Chairman, Indian Airlines), Air Force (Air Marshal Kapil Chadha, AOC-in-C Eastern Air Command) and industry (Mr J Bhandari, Chief of Planning, Hindustan Aeronautics Limited and later General Manager, Kanpur Division). The Menon Committee had extensive discussions with potential operators of such light transport aircraft, studied the size and performance parameters and worked out projected requirements till the end of the century before drawing a list of all available aircraft types then existing: British, Spanish, Canadian, West German, Czechoslovak, Brazilian, American and Australian. Various criteria were applied to each aircraft and four were eventually shortlisted for extensive technical, operational and financial evaluation: the Short Skyvan, Casa 212, DHC-6 Twin Otter and Dornier 228.

Nearly two years of examination, flight evaluation to the farthest limits of performance and intensive commercial and industrial negotiations followed before the Government of India confirmed, in August 1983, selection of the Dornier 228 as India's choice of light transport aircraft for Vayudoot, the IAF, the Navy and Coast Guard plus other operators.

Airbus : “competitiveness with efficiency, innovation and diversity”

Airbus marked key milestones in 2016, including service introductions of the A320neo (new engine option) jetliner; first deliveries of the latest A330 Family member tailored for regional routes; expansion of the A350 XWB operator base; start of final assembly for the A330neo; its 10,000th overall delivery and broadening of the company’s customer services support. Accompanying these achievements were significant new commercial orders from around the world for Airbus’ product line of single-aisle and widebody aircraft.

Highlighting Airbus’ continued growth, the aircraft manufacturer marked its 10,000th jetliner delivery to global customers with the 14 October 2016 handover of an A350-900 jetliner to Singapore Airlines. This major achievement spans more than four decades with every member of the Airbus airliner “family” contributing – from the cornerstone medium-haul A300 and A310 to the single-aisle A320 product line, long-range A330/340 Family, new-generation A350 XWB and double-deck A380. As of the 10,000th handover, the global Airbus fleet had flown some 215 billion kilometres and carried more than 12 billion passengers – a number representing approximately twice the Earth’s population.

History was made in 2016 with the first-ever delivery of a jetliner from the Airbus US manufacturing facility in Mobile, Alabama – a single-aisle A321 for operation by US-based carrier JetBlue. Airbus’ second handover from the final assembly line occurred less than one month later with the delivery of American Airlines’ very first US built Airbus aircraft – an A321. Taking the Alabama site into account, Airbus now has operational final assembly lines for the A320 jetliner product line on three continents: North America, Europe (at Toulouse, France and Hamburg, Germany), and Asia (at Tianjin, China).

Airbus meanwhile reached important production milestones for its A350 XWB Family’s longest-fuselage member, the



The commonality across Airbus’ product line – which includes the A320, A330, A350 XWB and A380 jetliners

A350-1000 for which Airbus is targeting a mid-2017 commercial service entry. The company has rolled out its the initial two aircraft, the first of which made its maiden flight in November last year. These jetliners were built at Airbus’ A350 XWB final assembly line in Toulouse, France concurrently with the baseline A350-900

version. Underscoring the high degree of commonality between the A350-900 and A350-1000, all final assembly line stations can accommodate both aircraft types.

Last year also marked the start of commercial service for Airbus’ A320neo (new engine option) Family, which offers airline operators ‘unbeatable fuel efficiency’



The A350-1000 is scheduled to enter service in 2017

by incorporating the very latest technologies, including two new-generation engine choices: Pratt & Whitney's PurePower PW1100G-JM and the LEAP-1A from CFM International.

Airbus has notched several important milestones that will continue the success story for the popular and versatile A330

Family. In late 2016, the company announced the start of final assembly for the very first A330neo (new engine option) jetliner. Airbus' first widebody NEO is a longer-fuselage A330-900 version, which alongside the A330-800 comprises this 'highly-efficient' product line's two versions. The A330neo Family builds on

the A330's proven economics offering a further 14 percent reduction in fuel burn per seat. Another significant development last year was handover for the first A330-300 Regional jetliner, which was received by Saudi Arabian Airlines. Tailored for regional and domestic operations, this A330 version is optimised for routes up to



The A350-1000 has a spectacular view of Aurora Borealis during its cold weather testing in Iqaluit, Canada

Revelations about the A350 XWB

The A350 XWB is Airbus' all-new mid-size long-range aircraft family and the newest member of Airbus' widebody family. The clean-sheet design A350 XWB is the 'world's most modern and efficient aircraft family, offering true long-range capability, unrivalled operational efficiency and the most exclusive passenger experience'. Its all-new efficient design includes the latest and unique technologies improving performance in operation. The A350 XWB offers a 25 per cent step change in fuel efficiency and a 25 per cent lower seat-mile cost compared to the in-service aircraft it is designed to replace. It also generates 25 per cent lower CO₂ emissions, making it the most eco-efficient aircraft.

The A350 XWB cross-section of 221 inches in width has been designed "inside out" to perfectly match all airlines' expectations. In a typical three class configuration, the A350 XWB cabin offers as standard a comfortable 18" seat width at 9-abreast in Economy, complemented with Premium Economy (8-abreast, wider seats and large armrests) and Business (4-abreast, or 5,6,7 abreast). The airliner is powered by new Rolls-Royce Trent XWB engines.

The A350 XWB has been awarded the Common Type Rating with the A330 (over 1,000 in service). Both Airbus widebody product lines are complementary: 86 per cent of A350 customers are A330 customers or operators. The A350 XWB also enjoys Cross Crew Qualification with the A320 Family (more in-service aircraft than any other jetliner).

Airbus forecasts a demand over the next 20 years for 8,100 (all manufacturers) new twin-aisle passenger and freighter aircraft. As of end-March 2017, there were 821 total A350 XWB orders from 44 customers and in-service a total of 75 A350-900s with 11 operators.



The A350-1000 jetliner's "High and Warm" flight test campaign in Latin America, which utilised Airbus' MSN071 test aircraft, included a visit to La Paz, Bolivia.

2,700 nm covering short- to medium-haul routes with up to five hours' flight time. As the A330-300 Regional's launch operator, Saudi Arabian Airlines is to operate a fleet of 20 jetliners, deploying the aircraft to boost capacity on some of its most in-demand regional/domestic routes.

Airbus also formally launched its innovative new jetliner cabin concept – *Airspace by Airbus* – which connects the company's commitment to passenger well-being and airline operational performance. Based on four key pillars, comfort, ambience, service and design,

Airspace by Airbus cabins offer a more relaxing, inspiring, attractive and functional environment for travellers. This sophisticated, flexible concept also will optimise cabin space for operators, while allowing them to project their brands and create next-generation flying experiences for passengers. The Airspace by Airbus cabin will be introduced with the widebody A330neo (new engine option) and incorporated onto the A350 XWB Family.

Highlighting the continued growth in commercial aviation aftermarket, Airbus is committed to delivering even more value-

adding services on par with the quality of its market-leading jetliners. Underscoring this growing focus was the announcement of the company's first-ever global services forecast – which projects \$3 trillion in aftermarket services spending over the next 20 years. The company also unveiled its new NAVBLUE flight operations and air traffic management company that combines the portfolios of Navtech (acquired by Airbus), Airbus ProSky and Airbus Flight Operations Services. NAVBLUE is reaching for the skies fueled by the agility of Navtech and the 'pioneering spirit of Airbus'.

Iranian officials took a significant step in modernising their country's commercial aviation sector by signing two agreements with Airbus. These accords covered the acquisition of 118 new aircraft, along with a comprehensive co-operation for developing Iranian air transportation infrastructure. With one agreement, Iran Air would acquire a full range of new Airbus jetliners (21 A320ceo Family aircraft, 24 A320neo family jetliners, 27 A330ceo family airlines, 18 A330-900neo versions, 16 A350-1000s and 12 A380s), while benefiting from Airbus' extensive resources in pilot and maintenance training, as well as customer support and services. The other accord was a comprehensive cooperation agreement for development of air navigation services, airport and aircraft operations, harmonised air regulations, technical and academic training, maintenance and repair operations, as well as industrial cooperation.

On 11 January 2017, Iran Air took delivery of its first new aircraft, an A321, in a handover ceremony in Toulouse attended by Farhad Parvaresh, Iran Air Chairman and CEO, and Fabrice Bregier, President, Airbus Commercial Aircraft and Chief Operating Officer Airbus, in the presence of Gael Meheust, SVP Sales and Marketing CFM, Tom Enders, Airbus Chief Executive Officer, and international media.

In a demonstration of Airbus' growing presence in the Asia-Pacific region, the company began construction of its A330 Completion and Delivery Centre (C&DC) at Tianjin, China where activities will include cabin installation, fuselage painting, engine run, production flights, as well as delivery to customers. The Tianjin-based C&DC will benefit from its co-location with the existing A320 Family final assembly line in this northern Chinese city. Aircraft processed at the Chinese



A320neo of Air Astana

Completion and Delivery Centre will be built at Airbus' A330 final assembly line in Toulouse, France, and then flown to Tianjin. Customer deliveries of finished A330s from Tianjin are scheduled to begin in September 2017.

Commenting on the company's progress, Tom Enders, Airbus Chief Executive Officer stated: "We have delivered on the commitments that we gave a year ago and achieved our guidance and objectives, with one exception, the A400M, where we had to take another significant charge totalling 2.2 billion euros in 2016. De-

risking the programme and strengthening programme execution are our top priorities for this aircraft in 2017. We recorded a net book-to-bill above one in a year we delivered more commercial aircraft than ever before. The record order backlog is supporting the ramp-up plans and our performance in 2016 shows we can deliver on that. We successfully managed the ramp-up of the single-aisle and A350 programmes while at the same time transitioning to the more efficient version of the A320. Our commercial performance in helicopters was good despite a difficult market environment

and we continued to strengthen and reshape the defence and space portfolio. We are taking additional steps to increase efficiency through the integration project, while investments in digital transformation will further improve our competitiveness. Overall, the progress we made last year gives us confidence that we have the building blocks in place to achieve our earnings and cash flow growth potential."

As the basis for its 2017 targets, Airbus expects to deliver more than 700 commercial aircraft.

[With inputs from Airbus]



Coming soon from Airbus: the BelugaXL, whose special livery design, including beluga whale-inspired eyes and a happy grin, were voted on by Airbus employees!

First off – and still the First !



Airbus and India

The Airbus story in India began in 1976, with delivery of three A300(B2)s to Indian Airlines – the first domestic airline customer for the type. The A300, and later the A310, were the aircraft that cemented the then-fledgling Airbus Industrie's reputation as a major manufacturer of aircraft, paving the way for the Company's modern successes such as the A330, A320, A380 and A350. Hundreds of A300/A310s remain in service today, and Airbus projects that some 200 will still be operational around the world in 2025,

more than half a century after the first A300 prototype took the air!

The very next Airbus product, the revolutionary fly-by-wire A320, saw similarly enthusiastic acceptance in Indian skies, and indeed has become something of a ubiquitous presence in the subcontinent. Once again, Indian Airlines was the first customer, taking delivery in 1989 but it was the economic liberalisation of the 1990s that laid the groundwork for the A320's runaway success in the Indian market. Nearly every new mainline airline established in the

2000s – from low-cost carriers Deccan, GoAir and Indigo, to full-service Kingfisher – adopted the A320 for their narrowbody needs. Later entrants to the market, AirAsia India and Vistara, also selected the A320 for their single-type fleets.

By the mid-2000s, the widebody A330 also began to receive some attention in India, and the A330-200 entered service with Jet Airways in April 2007. In December 2012, Jet received its first A330-300s, and put it into service on the Mumbai-Brussels route later that same month. Air India also briefly



Air India operated leased A330s in the 2000s

operated leased examples of the type, but Jet was and remains the only long-term owner and operator of the A330 in India.

The advent of 'sharklet' blended winglets for the A320 in place of the older wingtip fences, along with announcement of the re-engined 'new engine option' (neo), brought about something of an A320 resurgence not just in India but also the world. In 2011, when IndiGo was the fastest-growing carrier in India and soon to be the largest by market share, the airline placed a mammoth 180-aircraft order for 150 A320neo and 30 A320ceo. This was followed by a 72-aircraft order from GoAir in June that year.

In June 2014, new entrant AirAsia India, a joint venture of Malaysia's AirAsia Berhad, Tata Sons and Telestra Tradeplace, commenced operations in India, flying the A320. In January the next year, another Tata Sons joint venture, this time a full-service carrier called Vistara, in collaboration with Singapore Airlines (SIA), took to the skies, again exclusively on the A320.

Independence Day 2015 brought more headlines, with IndiGo confirming a 250-aircraft for the A320neo – the largest order by number in Airbus history. The airline became the first neo operator in India in March 2016, and is the world's largest operator of the new type, with over 20 currently in service.

GoAir followed IndiGo, taking delivery of its first A320neo in June 2016. The airline announced its intention to add another 72 neos to its fleet at the Farnborough Air Show in 2016, and firmed up this commitment in January 2017, taking their cumulative order book to 144 A320neos. In February 2017, Air India joined the ranks of Indian A320neo operators, with the first of fourteen leased CFM International LEAP-1A-powered A320neos arriving at New Delhi.

'Working in India'

Airbus' industrial cooperation with India began in the 1980s when an agreement was reached with Hindustan Aeronautics Limited (HAL) to manufacture forward passenger doors for the A320. HAL now produces half of all A320 forward passenger doors. In addition, Airbus' list of Indian partners and suppliers has expanded to encompass engineering, IT services, technical publications, research and technology and manufacturing of aero-structures, detail parts and sub-assemblies. More than 5,000 professionals nationwide

Will Vistara be the first with A350 in India ?

Vistara, having received the last of 13 A320neos on order in 2016, is now planning a major fleet expansion for domestic operations and the introduction of international services, for which it projects a requirement of 100 single-aisle aircraft and 40 widebody types. The airline will begin formal evaluation in the course of 2017, and given existing experience with the A320 family, is likely to stay with Airbus for its narrowbody needs. While the field will certainly be broader for the widebody selection, it is likely that the new A350 XWB will be in contention with the aim of keeping Vistara an 'all-Airbus' airline.



Vistara could well be the Indian launch customer for the A350

contribute directly or indirectly to all Airbus aircraft programmes.

Airbus India Engineering, for example, specialises in high-tech aeronautical engineering, with 350-plus Indian engineers working hand-in-hand with other Airbus offices around the world, as well as with the Indian aerospace industry. The Bangalore-based centre focuses on development of advanced capabilities in the areas of modelling and simulation, embedded systems software, systems installation, digital mock-up, structural analysis, materials and properties, loads and weight estimations, system testing, computational fluid dynamics (CFD), as well as process, methods and tools – with impact on a range of aircraft programmes such as the A380, A350 XWB and A320neo.

Airbus has a similarly broad training and support footprint in the country, and Airbus Training India (ATI) in Bangalore has provided maintenance training to more than 2,250 people from airlines in India and neighbouring countries. An Airbus preferred pilot training centre was established in the national capital region in cooperation with CAE and Interglobe in 2013, and a dedicated Airbus Training Centre is under construction near Delhi's international airport, intended to be operational by end-2018. Airbus' enhanced customer support network from India covers India, Sri Lanka, Bangladesh and the Maldives. Customers in India are supported from two hubs in Mumbai and Delhi.



Vistara has ambitious growth plans that could see Airbus further increase its footprint in the subcontinent

Business Aviation Forecast



A Bombardier Global Express shortly after take off

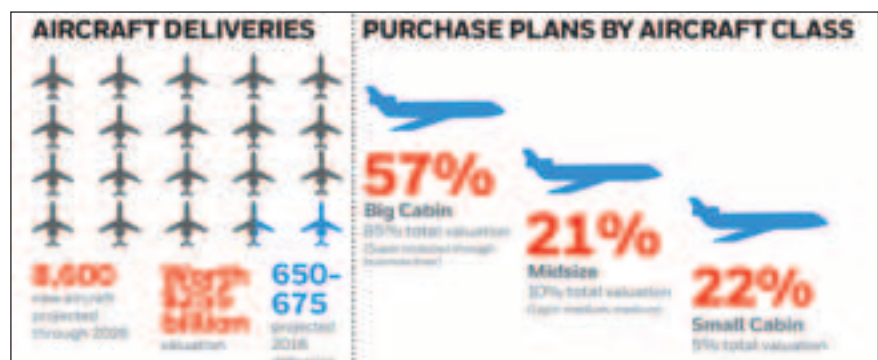
Slow near-term growth

The business aviation industry continues to face a slow near-term pace of orders owing to slow-growth across many global markets along with many political uncertainties, according to the 25th annual *Global Business Aviation Outlook* released by Honeywell. This forecasts up to 8,600 new business jet deliveries worth \$255 billion from 2016 to 2026, which represents a 6 to 7 percent reduction from that noted in the 2015 forecast. “We continue to see relatively slow economic growth projections in many mature business jet markets. While developed economies are generally faring better, commodities demand, foreign exchange and political uncertainties remain as concerns,” said Brian Sill, president, Commercial Aviation, Honeywell Aerospace. “These factors continue to affect near-term purchases, but new survey responses indicate there is improved interest in new aircraft acquisition in the medium term, particularly in the 2018–19 period. In the meantime, operators surveyed indicated plans to increase usage of current aircraft modestly in the next

12 months, providing some welcome momentum to aftermarket activity, which has been flat recently.”

Deliveries of approximately 650 to 675 new jets took place in 2016, a low- to mid-single-digit percentage decline year on year. This comes after a small increase in 2015 and was largely due to slower order rates for mature models and a stabilisation in fractional-usage type of aircraft deliveries. The 2017 deliveries are projected to be slightly lower, reflecting transition to new

models slated for late 2017 and 2018 service entry. Operators plan to make new jet purchases equivalent to about 27 percent of their fleets over the next five years as replacements or additions to their current fleet, an encouraging increase but one that is less than firm on timing. Of the total purchase plans for new business jets, 21 percent are intended to occur by the end of 2017, while 18 percent are scheduled for 2018 and 2019, respectively. Operators will continue to focus on larger-cabin



Source: Honeywell Aerospace



A privately owned Gulfstream G650 (photo: Adrian Pingstone)



Dassault's long-range trijet Falcon 7X (photo: Sergey Kuzmishkin)

aircraft classes, ranging from super mid-size through ultralong-range and business liner, which are expected to account for more than 85 percent of all expenditures on new business jets in the next five years. The longer-range forecast through 2026 projects a 3 to 4 percent average annual growth rate despite the lower short-term outlook as new models and improved economic performance contribute to industry growth. Gains in five-year operator purchase plans are offset in the long-term forecast based on changes in new programme timing, slower economic growth projections, and political and currency uncertainties, resulting in a moderately lower overall outlook.

Continued increase in Chinese and Russian purchase plans compared with the previous year, coupled with slight gains in



A Cessna 560XL Citation XLS over Innsbruck, Austria (photo: Fabrizio Gandolfo)

the larger Brazilian survey outlook, will drive improved results in the BRIC nations. Brazil remained a bright spot by recording

the strongest new aircraft purchase plans in the survey although overall buying plans rose only slightly year over year.

An Airbus A318CJ (photo: H Gousse/Airbus)



The Boeing Business Jet (BBJ) was selected for the IAF's VIP Communication Squadron

Publications by The Society for Aerospace Studies on

Naval Aviation



On The Wings of Gold

Golden Jubilee of INS Hansa
by Pushpindar Singh

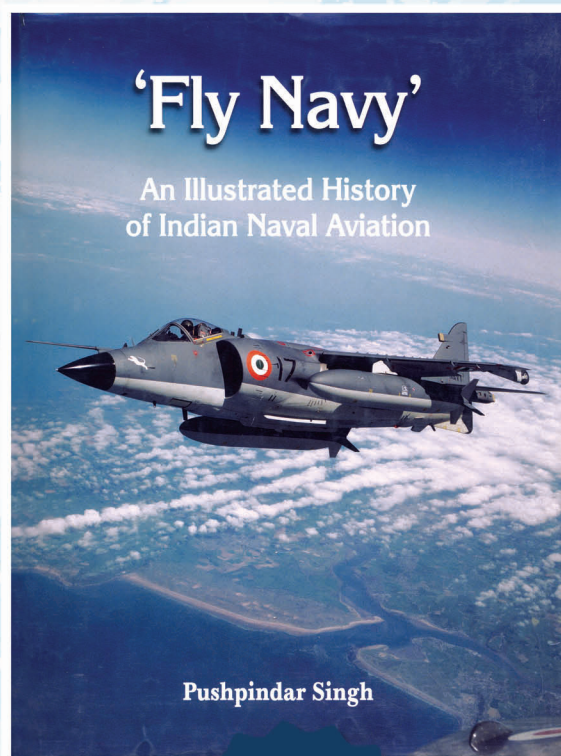
This book explores in comprehensive detail the history of the Indian Navy's largest and most active Naval Air Station, INS Hansa, at Dabolim in Goa. From the Station's beginnings as the Naval Contingent, Coimbatore in September 1961, to the move to its present day home in Goa in 1964, and right up to contemporary times, this richly illustrated book details the growth and evolution of the Station as well as all Naval Air Squadrons associated with it.

'Fly Navy'

An Illustrated History of Indian Naval Aviation
by Pushpindar Singh

The first dedicated history of Indian Naval Aviation, this book contains hundreds of rare photographs a treasure trove of painstakingly collected information on India's Naval Air Arm, making it a tremendous resource for enthusiasts and analysts alike.

In his Foreword, Admiral Arun Prakash, then Chief of the Naval Staff observed that "over half a century after the first Short Sealand amphibian flew into Cochin, marking the foundation of our Fleet Air Arm, India's naval aviation has grown to the size of a respectable air force. Even as the navy's growth as a maritime force is seen to be inextricably linked to India's renaissance as a major Indian Ocean power, aviation has progressively assumed centrality in our operational planning"



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Limited
Stocks!



“Best Performance



An Air India Express ATR 72-600 seen on approach for landing (photo: Angad Singh)

The International Air Transport Association (IATA) expects the global airline industry to make a net profit in 2017 of \$29.8 billion. Total revenues of \$736 billion, which represents a 4.1% net profit margin have been forecast. This will be the third consecutive year (and the third year in the industry's history) in which airlines will make a return on invested capital (7.9%) which is above the weighted average cost of capital (6.9%).

IATA revised slightly downward its outlook for 2016 airline industry profitability to \$35.6 billion (from the June projection of \$39.4 billion) owing to slower global GDP growth and rising costs. This will still be the highest absolute profit generated by the airline industry and the highest net profit margin (5.1%).

“Airlines continue to deliver strong results. This year we expect a record net profit of \$35.6 billion. Even though conditions in 2017 will be more difficult with rising oil prices, we see the industry earning \$29.8 billion. That's a very soft landing and safely in profitable territory. These three years are the best performance in the industry's history—irrespective of the many uncertainties we face. Indeed, risks are abundant— political, economic and security among them. And controlling

costs is still a constant battle in our hyper-competitive industry,” said Alexandre de Juniac, IATA's Director General and CEO.

“We need to put this into perspective. Record profits for airlines means earning more than our cost of capital. For most other businesses that would be considered a normal level of return to investors. But three years of sustainable profits is a first for the airline industry. And after many years of hard work in restructuring and re-



Malaysian Airlines A380 during an air show demonstration (photo: Alex Beltyukov)

in the Industry's History"



engineering the business the industry is also more resilient. We should also recognise that profits are not evenly spread with the strongest performance concentrated in North America," said de Juniac.

"Soft landing in 2017"

While airline industry profits are expected to have reached a cyclical peak in 2016 of \$35.6 billion, a soft landing in profitable territory is expected in 2017 with a net profit of \$29.8 billion. 2017 is expected to be the eighth year in a row of aggregate airline profitability, illustrating the resilience to shocks that have been built into the industry structure. On average, airlines will retain \$7.54 for every passenger carried.

Expected higher oil prices will have the biggest impact on the outlook for 2017. In 2016 oil prices averaged \$44.6/barrel (Brent) and this is forecast to increase to \$55.0 in 2017. This will push jet fuel prices from \$52.1/barrel (2016) to \$64.9/barrel (2017). Fuel is expected to account for 18.7% of the industry's cost structure in 2017, which is significantly below the recent peak of 33.2% in 2012-2013.

The demand stimulus from lower oil prices will taper off in 2017, slowing traffic growth to 5.1% (from 5.9% in 2016). Industry capacity expansion is also expected to slow to 5.6% (down from 6.2% in 2016). Capacity growth will still outstrip the increase in demand, thus lowering the global passenger load factor to 79.8% (from 80.2% in 2016).

The negative impact of a lower load factor is expected to be offset somewhat by a strengthening of global economic growth. World GDP is projected to expand by 2.5% in 2017 (up from 2.2% in 2016). Along

with structural changes in the industry, this is expected to help stabilise yields for both the cargo and passenger businesses. This is a welcome development as yields (calculated in dollar terms) have fallen each year since 2012.

There is some optimism over the prospects for the cargo business in 2017. The break in falling yields and a moderate uptick in demand (3.5%) will see cargo industry volumes reach a record high of 55.7 million tonnes (up from 53.9 million tonnes in 2016). Industry revenues



An Air India Boeing 777-200LR shortly after take-off



The Bombardier CSeries commenced revenue service in July 2016, with Swiss as launch operator

are expected to rise slightly to \$49.4 billion (still well below the \$60 billion level of annual revenues experienced in 2010-2014). Trading conditions remain challenging.

4 Billion Travellers

“Connectivity continues to set new records. We expect nearly 4 billion travelers and 55.7 million tonnes of cargo in the

coming year. And almost 1% of global GDP is spent on air transport—some \$769 billion. Air transport has made the world more accessible than ever and it is a critical enabler of the global economy,” said de Juniac.

“Governments, however, do not make aviation’s work easy. The global tax bill has ballooned to \$123 billion. Over 60% of countries put visa barriers in the way of

travel. And the total number of ticket taxes exceeds 230. Billions of dollars are wasted in direct costs and lost productivity as a result of inefficient infrastructure. These are only some of the hurdles which confront airlines. Our aim is to work in partnership to help governments better understand and fully maximise the social and economic benefits of efficient global air links,” stressed de Juniac.



Over 1,000 Embraer E-Jet regional airliners have been delivered worldwide (photo: Andre Wadman)

Regional Analysis for 2017

North American carriers: The strongest financial performance is being delivered by airlines in North America. Net post-tax profits will be the highest at \$18.1 billion next year, although down slightly from the \$20.3 billion expected in 2016. The net margin for the region's carriers is also expected to be the strongest at 8.5% with an average profit of \$19.58/passenger. In 2017 capacity offered by the region's carriers is expected to grow by 2.6%, slightly outpacing expected demand growth of 2.5%. Recent consolidation continues to underpin the region's strong profitability,

taxes. And terrorist threats remain a real risk, even if confidence is starting to return after the tragic incidents in recent times.

Asia-Pacific carriers: Airlines in the Asia-Pacific region are expected to generate a net profit of \$6.3 billion in 2017 (down from \$7.3 billion in 2016) for a net margin of 2.9%. On a per passenger basis average profits are anticipated to be \$4.44. Capacity offered by the region's carriers is forecast to grow by 7.6%, ahead of a forecast growth in demand of 7.0%. Improved cargo performance is expected to offset rising fuel prices for many of the region's airlines. The expansion of new model airlines and

in airport charges across the Gulf States and growing air traffic management delays.

Latin American carriers: Latin American airlines are expected to post a net profit of \$200 million, which is slightly lower than the \$300 million forecast for 2016. Profit per passenger is expected to be \$0.76 with a net profit margin of 0.7%. Capacity offered by the region's carriers is forecast to grow by 4.8% which is ahead of expected demand growth of 4.0%. Despite some signs of improvement in the region's currencies and economic prospects, operating conditions remain challenging, with infrastructure deficiencies, high taxes,



Sukhoi Superjets have entered service beyond Russian borders, notably with Mexican operator Interjet

even as the region faces upwards cost pressures which include the price of fuel.

European carriers: Airlines based in Europe are expected to post an aggregate net profit of \$5.6 billion in 2017, which is below the \$7.5 billion for 2016. Nonetheless, carriers there are forecast to generate a 2.9% net profit margin and a per passenger profit of \$5.65. There remains a significant gap between the performance of the region's carriers and the performance of North American ones. Capacity in 2017 is expected to grow by 4.3%, ahead of demand growth which is forecast at 4.0%. The region is subject to intense competition and hampered by high costs, onerous regulation and high

progressive liberalisation in the region is intensifying already strong competition. In addition profitability varies widely across the region.

Middle Eastern carriers: Middle Eastern airlines are forecast to generate a net profit of \$0.3 billion for a net margin of 0.5% and an average profit per passenger of \$1.56. This is below the \$900 million profit expected in 2016. Average yields for the region's carriers are low but unit costs are even lower, partly driven by the strong capacity expansion, forecast at 10.1% this year, ahead of expected demand growth of 9.0%. Threats are emerging to the success story of the Gulf carriers, including increases

and a growing regulatory burden across the continent. Meanwhile, Venezuela continues to block the repatriation of some \$3.8 billion of industry funds in contravention of international obligations.

African carriers: Carriers in Africa are expected to deliver the weakest financial performance with a net loss of \$800 million (broadly unchanged from 2016). For each passenger flown this amounts to an average loss of \$9.97. Capacity in 2017 is expected to grow by 4.7%, ahead of 4.5% demand growth. The region's weak performance is being driven by regional conflict and the impact of low commodity prices.

Extracts from IATA reports

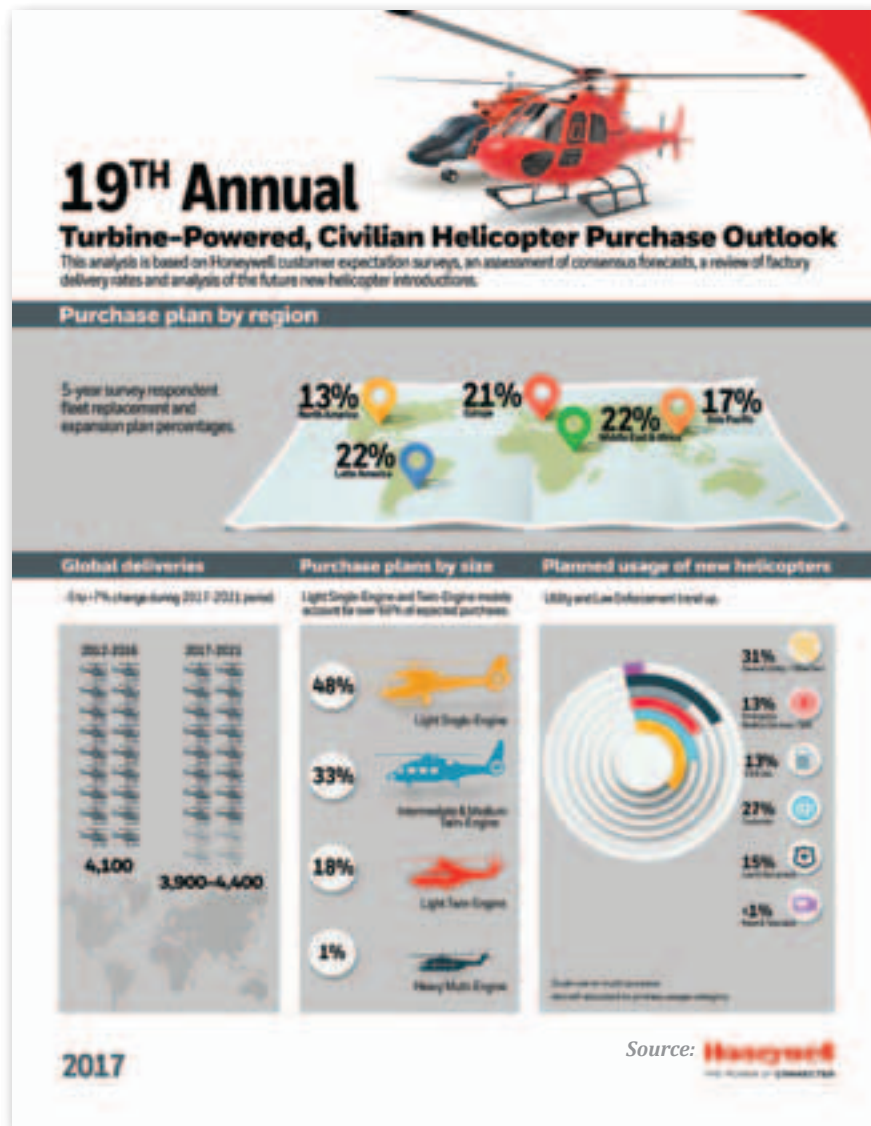
Global helicopter 5 year forecasts

A Cautious Outlook

Impacted by a slow global economic growth environment and volatility in oil and gas-related markets, the helicopter industry is reacting with a cautious outlook for near-term new purchases. In its 19th annual 'Turbine-Powered Civil Helicopter Purchase Outlook,' Honeywell forecasts 3,900 to 4,400 civilian-use helicopters will be delivered from 2017 to 2021, roughly 400 helicopters lower than the 2016 five-year forecast. "The current global economic situation is causing fleet managers to evaluate new helicopter purchases closely, and that is why we are seeing a more cautious five-year demand projection compared with previous years," stated Ben Driggs, President, Americas, Honeywell Aerospace. "Even in a slow growth environment, Honeywell is well-positioned to help operators keep current fleets lasting longer with aftermarket upgrades and repairs."

The survey showed new purchase-plan rates were lower for the next five years, for all regions, leading to a more cautious near-term outlook. When considering a new purchase, operators' results mirrored those from last year, with make and model choices for their new aircraft most strongly influenced by range, cabin size, performance, technology upgrades and brand experience. Helicopter fleet utilisation in the past 12 months generally increased compared with last year. Over the next 12 months, usage rates are expected to improve significantly in North America and Latin America, but at a reduced rate in Europe.

Latin America: The 2017 results show lower fleet replacement and growth expectations compared with 2016 results. Still above the world average, the purchase plans have declined more than 13 percent compared with the prior year. Latin America led all global regions in the rate of new aircraft purchase plans, but is down year over year and impacted by weak economic performance in Brazil and Venezuela. Latin American respondents currently favour light single-engine models, representing almost 60 percent of their planned acquisitions, followed by intermediate and medium twin-engine platforms.



Middle East and Africa: The region has the second-highest new purchase rate among the regions, with up to 22 percent of respondent fleets slated for turnover with a new helicopter replacement or addition. However, purchase plans are 8 percent lower compared with 2016 survey results. Close to 80 percent of planned new helicopter purchases are intermediate and medium twin-engine models. Light single-engine models are the second-highest-mentioned platform in the survey by operators.

North America: Purchase expectations fell by more than 2 percent in this year's survey. The purchase plans are down for a second year since 2015. More than 75 percent of planned North American purchases were identified as light single-engine models, while just under 13 percent of new purchases were slated as intermediate or medium twin-engine models. North American purchase plans are a significant component of the overall 2017 survey demand, as the region represents more than 40 percent of the current world fleet.



The Light Utility Helicopter from HAL, India



Leonardo's AW189

Europe: Purchase plans decreased by more than 3 percent in this year's survey, down for a second year in a row. The sample of Russian operators responding in the 2017 survey remains small, which continues to add some uncertainty to the overall European results. Excluding heavy-twin helicopters, European purchase intentions currently tend to favor all classes in nearly equal shares this year.



*Lockheed Martin/
Sikorsky S-76*

Asia Pacific: Despite solid results from these nations, overall buying plans slipped about 1 percent. Operator purchase plans continued to drift slightly lower compared with the past few years in the 2017 results. APAC operators tended to focus more on corporate and oil and gas end uses for their new purchase plans, and consequently, intermediate and medium twin-engine helicopters were the most popular models in their new aircraft plans. India held fairly steady year over year based on very small sample input. There are a number of countries contributing more relative and



Airbus Helicopters H135

absolute new helicopter purchase plans in the region including China, Australia, South Korea, Japan and Malaysia.

BRIC countries (Brazil, Russia, India and China): Purchase plans are lower for all countries except Russia in this year's survey. Overall, BRIC plans are down more than 11 percent compared with 2016 results. Brazilian purchase plans are down significantly, by almost 20 percent in 2017, reflecting the impact of the economic recession in the country. Small sample sizes in Russia and India make it difficult to draw conclusions and planned Chinese purchase rates slipped, reflecting near-term slower economic growth prospects.



Bell Helicopters 429



Russian Helicopters Ansat-K

NEW WINGS FOR THE



IN317 in flight over the base

Indian Navy Tu-142s phased out

On 29 March 2016, the Indian Navy's iconic Tu-142M 'Bear-Foxtrot' long-range maritime reconnaissance (LRMR) and ASW aircraft were retired after 29 years of service with INAS 312 ('Albatross'). Having comprehensively covered the Indian Navy's long-range maritime patrol operations out of INS Rajali at Arakkonam in the state of Tamil Nadu (see Vayu VI/2014), Angad Singh of Vayu returned to this secluded air station to bid the Type farewell.

Indian Naval Air Station *Rajali* in 2017 is almost a different place compared to that in 2014. The entrance remains the same, but instead of the deafening roar of Soviet-era turboprop engines driving massive eight-bladed contra-rotating propellers, much quieter modern western CFM turbofans now create the decibels. The only Tupolevs

that loom large over the foliage on this lush base are the bleached mothballed airframes parked by the south-western end of the massive runway (arguably the longest in South Asia). Only two Tu-142Ms of INAS 312 are still active. One has already been converted to a museum exhibit on the north side of the runway and all new construction

underway is solely intended to support the eight new Boeing P-8Is that will supplant the Tu-142Ms. The capability and reliability leap from this transition does not need to be pointed out, but one cannot help but sentimentally feel that the sleepy hamlet of Arakkonam is being robbed of much of its unique character !

ALBATROSS



As is the case with most Soviet (and latterly Russian) aircraft in service with the Indian military, the Tu-142M's Achilles' Heel has always been maintenance. The impressive capabilities of these machines are fielded through a massive maintenance effort both in India and Russia. The aircraft required overhaul in Russia at approximately 1,500-hour intervals, which meant each aircraft was dispatched to the Beriev Aircraft Company in Taganrog, Russia every 5 to 7 years depending on flying intensity. It took approximately one year to complete overhaul of a single aircraft, and 21 Indian Navy Tupolevs have been overhauled during the type's 29 years of service. The last of these, IN317, was handed over to the Navy on 6 August 2014 at the Taganrog plant, before making the long journey back to Arakkonam.

With no aircraft lost to attrition since induction, and an impressive safety record of over 30,000 accident-free flying hours since the type's induction, the principal driver behind the type's retirement was the age of the aircraft and the effort required to keep them airworthy. Their operating costs were also viewed unfavourably compared to smaller aircraft such as the Il-38SDs of INAS 315 ('Stallions') or newer aircraft such as the P-8Is. With the arrival of the Boeing P-8I, it was decided that the Tu-142s would be phased out once they had been replaced one-for-one by the American aircraft. Around 2014, the MoD decided that no further Tu-142 overhauls would be sanctioned and that individual aircraft would be progressively withdrawn as they came up against their flying hour limits.

On this writer's visit to INS *Rajali* in October 2014, the squadron had three operational aircraft, four cannibalised or



IN317 takes off past the short ATC tower at INS Rajali



IN317 landing at Rajali

in-Chief, Eastern Naval Command, Flag Officer Naval Aviation, RAdm PK Bahl, and Assistant Chief of Naval Staff (Air) RAdm Philipose G Pynumootil. Vice Admiral (ret.) Vinod Pasricha, who was instrumental in identifying and establishing Arakkonam as a naval air station in the 1980s, was also present. Master Chief Petty Officer Daler Singh, who was a member of the commissioning crew of the Tu-142s in 1988, had the unique distinction of serving with the type from induction through to its withdrawal from use, and was felicitated at the ceremony.

stored, and one being prepared for storage. By late 2016 only two (IN312 and 317) remained airworthy, and heavy checks were approaching. The Navy decided that the Tupolevs would be withdrawn after the annual month-long Theatre Readiness Operational Exercise (TROPEX) scheduled for January 2017, and in early March an out of service date of 29 March was then taken.

The retirement ceremony was timed to coincide with the Silver Jubilee of INS *Rajali*, which drew serving and retired officers from all over the country to the sleepy southern town. Chief of the Naval Staff, Admiral Sunil Lanba, was Chief Guest, attending along with Vice Admiral HCS Bisht, Flag Officer Commanding-



This Il-38SD from Goa took part in the flypast



IN317 receives a watercannon farewell salute as it returns to the apron



And so to bed !



1st Day Cover commemorating the Silver Jubilee of INS Rajali

After the customary speeches, a ‘maritime patrol’-themed flypast took place over the base, led by three Chetaks from the co-located Helicopter Training School, followed by a pair of maritime recce Dornier 228s, a single Il-38SD from Goa, a single Tu-142 (IN317) flown by INAS 312 CO Cdr Yogendra Mair and the squadron Senior Pilot Cdr Rana S Dutt, with a lone Boeing P-8I bringing up the rear.

IN317 then landed and taxied to the P-8 apron, where it was received by a watercannon salute before parking next to a pre-positioned P-8I. Cdr Mair exited the aircraft and handed over command of



A Boeing P-8I passes dispensing flares



Admiral Sunil Lanba Chief of the Naval Staff with the women observers of P-8I (photo: PRO Navy)



Cdrs Mair and Ranganathan with a P-8I after the flypast at Arakkonam



Tu-142M on static display being inaugurated by Admiral Sunil Lanba Chief of the Naval Staff (photo PRO Navy)

the squadron to Cdr V Ranganathan, who had until then been heading the 'Alpha flight' or 'A-flight' of INAS 312, exclusively operating the P-8I. INAS 312A, unofficially nicknamed 'Sky Lions,' now took over the storied *Albatross* moniker as a lone P-8I flew low over the runway carrying out a spectacular dump of all 120 flares carried on board.

The Tupolev personnel of INAS 312 will all find new berths in the Navy. Cdr Mair will move to HQ Naval Aviation at Goa, his Senior Pilot Cdr Dutt is going to INAS 550 at Cochin, while the two remaining Tu-142 pilots, Cdr Ranvir S Dhillon and Lt Cdr SS Tiwari, will convert to P-8Is, with training to be conducted on civilian simulators at a facility in Gurgaon, near New Delhi. The bulk of the engineering personnel will also convert to other types, with some remaining at *Rajali* on P-8Is, and others heading to Goa to offer much-needed manpower to the growing MiG-29K fleet at that station. The last two airworthy Tu-142s will soon make their way to other parts of the country to be preserved while they can still be flown, as breaking the aircraft down for transport is anticipated to be an impossibly expensive and time-consuming affair. A senior flag officer at *Rajali* stated that the Navy is "hoping to preserve as many Tu-142s as possible," but acknowledged the difficulties involved.

So, INAS 312 with Boeing P-8Is will become the largest naval air squadron in terms of personnel, tasking and infrastructure, and the Indian Navy has already ordered four more of the type, although these will probably operate from another base when they begin to arrive from 2019 onwards.

(Text and photos by Angad Singh except where marked)

For the Scrap Book



A number of old Tu-142Ms are stored just off the southern end of the runway



A look into the weapons bay of a Tu-142M



This complex mechanical Tu-142M flight deck will now give way to the modern all-glass 737 cockpit

The LCA Navy

To Sea or not to Sea



This computer generated image of the INS Vikrant (IAC-1) shows MiG-29Ks on deck (courtesy DND)

On the eve of Navy Day, 4 December 2016, the ‘Silent’ Service made an outspoken announcement in which it peremptorily rejected the shipborne variant of the Tejas light combat aircraft (LCA) which has been under development at ADA for over a decade. For those outside the corridors of South Block, this was somewhat surprising, considering it was

the Navy which, unlike the Air Force, had championed its LCA (Navy) programme and had contributed considerable funding forwards its development since 2003. Former CNS, Admiral Arun Prakash, who has for long been an outspoken advocate of indigenisation, commented on the Navy’s rejection of the Tejas as “a lesson ... failure of the DRDO (and) ... one can deduce

two compelling reasons for this, seemingly, radical volte face by the only Service which has shown unswerving commitment to indigenisation (lately labelled ‘Make in India’) for the past six decades”.

As he continued: “Firstly, by exercising a foreclosure option, the IN has administered a well-deserved and stinging rebuke to the Defence Research & Development Organisation for its lethargic and inept performance that has again disappointed our military. The second reason arises from the navy’s desperate hurry to freeze the specifications of its second indigenous aircraft carrier (labeled IAC-2). The choice of configuration, size and propulsion of a carrier has a direct linkage with the type of aircraft that will operate from it. This constitutes a ‘chicken and egg’ conundrum -- should one freeze the carrier design first or choose the aircraft first? The IN has, obviously decided the latter”.

To the public at large, this was perplexing as some “knowledgeable”



LCA Navy (NP-2) comes in to land (photo ADA)

observers had continuously opined that, for example, “even as the Indian Air Force wrangles over details in the manufacture and induction of its first squadron of Tejas light combat aircraft (LCA), the Indian Navy is powering ahead with its programme to develop a naval version of the Tejas”. The Naval LCA project had got a major fillip when the second prototype made its first flight on 7 February 2015, the first LCA Navy prototype having been the two-seater (NP-2). That aircraft had been piloted by Captain Shivrath Dahiya, a naval test pilot with the National Flight Test Centre (NFTC), while another Tejas, piloted by Group Captain Suneet Krishna ‘tail chased’ NP-2 all through its flight.



Captain Shivrath Dahiya, of the NFTC with Gp Capt M Rangachari, CO No.45 Squadron, IAF at Aero India 2017 (photo: Vayu)

The ADA spokesman articulated that “like all naval fighters, NP-2 has a reinforced undercarriage to absorb the impact of landing on aircraft carriers. Since the pilot must descend steeply to touch down precisely at a spot on the carrier deck where his aircraft’s tail-hook catches on a set of ‘arrestor wires’, this landing is often likened to a ‘controlled crash’, the ADA team elaborated.



LCA Navy NP-1 (photo : ADA)

Further, the NP-2 “corrected several deficiencies observed whilst flight-testing of NP-1 and incorporated most avionic hardware components that the Navy had demanded. These included ‘plug and play’ modules that would accept software modifications for aircraft carrier landing aids like a Levcon Air Data Computer, auto-throttle, and special lights. NP-2 will also incorporate the arrestor hook, a digital data link for tactical information, and the Israeli Derby beyond in visual range air-to-air missile”.

Thereafter, the Naval LCA programme transitioned from regular runways at HAL’s Bangalore Airport to the Shore Based Test Facility (SBTF), a full-sized, land-based model of an aircraft carrier deck that has been built at the Naval Air Station, Dabolim at Goa. In December 2015, NP-1 first operated from the SBTF and by February 2017, over 13 launches had been made, by day and night. The next major step in the Naval LCA project was, importantly, arrestor-wire landings to be carried out at the SBTF.



Tail Tales : The first series production LCA Mk.I for the IAF (LA-5001) seen next to LCA Navy NP-2 (3002) (photo : Vayu)

LCA Navy NP-2 landing at INS Hansa, Dabolim (photo : ADA)



LCA Navy NP-2 takes off from the SBTF at INS Hansa (photo : ADA)



But reverting to the LCA Navy ‘saga’, as Admiral Arun Prakash refers to, “as far back as the early 1990s, the navy had initiated a study for examining the feasibility of adapting the LCA to shipborne use. While

confirming feasibility, the study had revealed some major problem areas, which included lack of engine thrust, requirement of an arrestor hook and stronger undercarriage, and need for cockpit/fuselage re-design before the LCA could attempt carrier operations. Undaunted by the challenges, the Navy still re-affirmed its faith in the programme by contributing over Rs 400 crore as well as engineers and test pilots to the project”.

Meanwhile although the IAF had accepted the Tejas LCA Mk.I into service in July 2016, this was with considerable reservations because the aircraft had not been cleared for full operational exploitation and fell short of many IAF qualitative requirements. Even though the prototype LCA (Navy) had rolled out six years earlier, in July 2010, raising great hopes in the IN, it was obvious that the DRDO had failed to resolve the many short coming leading to ultimate rejection of this ambitious project.”



Dramatic view of LCA Navy NP-2 as it leaves the SBTF ramp(photo : ADA)

The dilemma for the Navy was summed up by Admiral Arun Prakash. “Indian Navy’s ‘Super Carrier’ IAC-2 will enter service in the next decade at a juncture where a balance-of-power struggle is likely to be under way in this part of the world with China and India as the main players. It is only a matter of time before China’s carrier task-forces, led by the ex-Russian carrier *Liaoning* and her successors, follow its nuclear submarines into the Indian Ocean. Since the Indian response to such intimidation will need to be equally robust, the decisions relating to the design and capabilities of IAC-2 (and its sisters) assume strategic dimensions. Essentially, there are three options for selection of aircraft for the IAC-2:



LCA Navy NP-2 (photo : ADA)



Representative image of Indian Navy aircraft carrier (INS Viraat) with escorts at sea (photo : Indian Navy)

CATOBAR : Conventional take-off and landing types like the US F/A-18 Super Hornet and French Rafale-M which require a steam catapult for launch and arresters-wires for recovery. This relatively large ship would need either a steam or nuclear plant for propulsion.

STOBAR : Types like the Russian Sukhoi Su-33 and MiG-29K would require only a ski-jump for take-off and arresters-wires for landing, which would mean a smaller carrier, driven either by gas turbines or diesel engines. The LCA (Navy) could have been a contender in this category, as indeed would the projected Gripen M.

VTOL : The F-35B Lightning II version of the US Joint Strike Fighter, capable of vectored-thrust, would require only a ski-jump for take-off, but no arresters wires since it can land vertically. This would result in the simplest and cheapest ship; a short take-off and vertical landing (STOVL) carrier.

Logically, once the IN has selected its carrierborne fighter, the ship and its operating and maintenance facilities could be designed around it, thus obviating some of the pitfalls encountered on IAC-1.

RFI for the MRCBF

Then, in swift follow up to its 3 December 2016 announcement, the Navy issued a formal Request for Information (RFI) for 57 multi-role carrier borne fighters (MRCBF) on 20 January 2017. As per this documents “the MRCBF is intended to be day and night capable, all-weather multi-role deck-based combat aircraft which

can be used for Air Defence (AD), Air to Surface Operations, Buddy Refuelling, Reconnaissance, EW missions etc from IN aircraft carriers.”

The Navy stipulated that the eventual acquisition process “will be awarded under the terms of the Defence Procurement Procedure of 2016 and will require deliveries of the aircraft to ‘commence



MiG-29Ks of INAS 303 on board INS Vikramaditya

within three years post conclusion of contract, and be completed within further period of three years’.” However, the RFI did not stipulate the required number of engines or if the aircraft was to be STOBAR or CATOBAR capable but enquired as to “how many engines does the aircraft have? Does the aircraft have capability to operate from both STOBAR (Short Take-off But Arrested Recovery) and CATOBAR (Catapult Take-off But Arrested Recovery) aircraft carriers without any modification to the aircraft” ?

Further, the RFI sought if “the main landing gear is capable of withstanding loads of holding on Restraining Gear System fitted on IN STOBAR aircraft carriers at maximum afterburner rating ? Is the Nose Landing Gear designed and capable of undertaking Catapult Launch from contemporary Steam and Electro Magnetic Aircraft Launch (EMAL) systems ? Is the aircraft capable of being launched from 13° and 14° ski-jumps having a parabolic profile using afterburner ? Is the aircraft capable of being launched from conventional steam catapult and EMALS ? What is the certified max Launch Weight for CATOBAR? Is the aircraft capable of arrestment with Svetlana arresting gear fitted on Indian aircraft carriers.”

The general Operational Clean Configuration (OCC) configuration implied carriage of four Beyond Visual Range (BVR) missiles and two All Aspect Air-to-Air Missiles (A4M) with 75 %

internal fuel and 100 % gun ammunition. Clean Configuration implies the aircraft with no external load and full internal fuel and gun ammunition’. As the RFI added, “Additional information on the ships that the MRCBF is expected to operate, may be sought for response and establishing feasibility of operating the aircraft from the same.”

Evolution of the LCA Navy Mk.II

So, is it over for the LCA Navy variant ? An emphatic ‘No’ ! was the response from the Aeronautical Development Agency (ADA), till lately headed by Commodore CD Balaji (ex-Indian Navy) and whose adjunct the NPTC has two distinguished Naval Test Pilots on its rolls.

As Commodore Balaji elaborated, as early as in December 2009, ADA had recognised that in the LCA Navy (Mk1), because of its lower engine thrust and the penalties in its re-engining, there were obvious shortfalls in full mission capabilities sought by the Indian Navy when operating from an aircraft carrier with ski ramp launch. Thus, a new programme with a higher thrust engine was sanctioned, and was labeled as the LCA Navy Mk2. “This programme envisaged minimising the constraints of LCA Navy Mk1 and would incorporate significant changes in design to improve aerodynamics, optimisation of the landing gear & arrestor hook system, entailing new structural design, integration of updated sensors, avionics, the flight control system

and son on. Balaji told *Vayu* that “ADA is moving ahead to design, develop and provide two prototypes designated NP3 and NP4 (both single-set fighters)”.

He summarised that “whilst the LCA Navy Mk1, was an adaption of the Air Force version to the Naval role and gave valuable inputs in the core carrier suitability technologies of ski-jump take-off and arrested recovery, the LCA Navy Mk2 is a new design conceptualised to be optimised for carrier borne application. The configuration is expected to provide a significant enhancement in terms of performance capability with aerodynamic and mass optimisation”.

Commodore Balaji emphasised that “significant design effort has been put in to realise such an aircraft that is capable of take-off from the ski jump with much heavier payloads as compared to the LCA Navy Mk1. The landing gear complexity has been reduced; consequently there is a mass optimisation. The arrestor hook installation has been optimised and blends with the bottom structure of the rear fuselage. These steps are considered as an essential step towards any potential twin engined deck based aircraft development in the country to be taken up in the future”.

According to Commodore Balaji, design work on the LCA Mk.2 was moving apace with some major design changes envisaged to the intakes and fuselage so as to accommodate the GE F414 engine, a batch of which have recently been delivered to ADA. The LCA Mk.2’s wings will be moved out board by about 350mm, increasing the space between fuselage and wings, thus optimising load transfer and allowing for an increase of fuel (700 kg) in the central fuselage.


Detailed design should be complete by 2019 and requisite raw material had already been ordered by ADA which aims to carry out the LCA Mk.2’s first flight in 2020-21. The full scale mockup of the LCA Navy Mk.2 should be ready by early 2018.

Making a direct reference to Saab, the intrepid designers at ADA believe that they are “at the same stage’ in terms of time and effort as are their Swedish counterparts with their Gripen M.

PSC



Image of the LCA Navy Mk.2 as projected at ADA's stand during Aero India 2017 (photo : Vayu)



Armed to the Hilt

Indian Navy's Anti-Ship Missiles

The Indian Navy's strategic prowess with missiles has been acknowledged ever since *Operations Trident* and *Python* during the 1971 War, which rendered the Pakistani Navy nearly inoperable and dislocated fuel and military supplies at the main port of Karachi. These tactical offensives represented the first use of anti-ship missiles (AShMs) – the Soviet-made P-15 Termit (SS-N-2 Styx) – in combat in the region, and only the second worldwide, after the sinking in 1967 of the Israeli Navy's INS *Eilat*, a former Z-class destroyer of the Royal Navy, off Port Said by Egyptian missile boats, also firing the Styx missile.

These milestones of modern naval warfare have induced smaller navies over the years to arm their platforms with AShMs and land-attack surface-to-surface missiles (SSMs). Leading the campaign for the missiles in India had been a band of Soviet-trained officers of the Indian Navy, nicknamed 'The Killers,' most of whom had been trained with the Soviet Pacific Fleet headquarters at Vladivostok in the late 1960s. These early beginnings led the Indian Navy to induct some very effective SSM systems over the years, and also initiated the indigenous development of crucial missile systems, aligned with the Navy's blue water mission.

The Indian Navy's maritime battlefield has of late been revolutionised in recent years by induction of the PJ-10 BrahMos, the world's first operational supersonic anti-ship cruise missile that has become the Navy's prime strike weapon. The versatile two-stage BrahMos, with a solid propellant booster and a liquid propellant ramjet system, is the result of an Indo-Russian agreement of 1998, its name representing the two great rivers Brahmaputra and Moskva. The joint venture firm, BrahMos Aerospace Private Limited (BAPL), is headquartered in New Delhi with its production facilities in Hyderabad.



INS Chamak firing a SS-N-2 Styx AShM

BrahMos's uniqueness, as also its superiority over other AShM and land-attack cruise missiles worldwide, is its unmatched speed – Mach 2.8 almost three times the speed of sound – which renders it near invincible and imparts enhanced strike power. These attributes are heightened by its stealth characteristics, high accuracy, and versatility in being launched from submarines or ships as well as from aircraft or from land, in either inclined or vertical configuration, depending on the type of platform and user requirements. Both the sea and land versions weigh 3 tonnes and have a length of 9 metres and diameter of 50 cm, with the capacity to carry a 200 to 300 kg warhead.

The missile can hit sea-based targets beyond radar horizons and is launched from the next generation Universal Vertical Launcher Module (UVLM), also designed and developed by BAPL. BrahMos can be fired singly or in a salvo towards single or multiple targets within intervals of 2 to 2.5 seconds in varied trajectories. A salvo of 8 missiles is deemed capable of penetrating and destroying an armada of frigates with modern anti-missile defences. Its intelligent characteristics are such that it is beyond prevailing missile detection capabilities, and its mid-course guidance is provided by inertial navigation system and its terminal course guidance, by homing radar seeker. It can be supplemented with GPS/GLONASS for accuracy augmentation.

The Indian Navy began inducting first versions of BrahMos in its frontline warships from 2005 and the missile will be deployed on all its platforms that can bear it. Among those it is deployed on are two of the five 3,950-tonne *Rajput*-class (*Kashin II*) guided missile destroyers (DDGs), INS *Rajput* and INS *Ranvir*, the six follow-on 3,840-tonne *Talwar*-class guided missile frigates (FFGs), and most recently, the three *Kolkata*-class Project-15A DDGs. It will also equip the four Project-15B *Visakhapatnam*-class DDGs, first of which will enter service in July 2018 and which, at 7,400 tonnes, are as large as the *Kolkata*-class whose hull they are modelled on. Each of these two classes will have two eight-cell UVLMs for 16 BrahMos missiles.



Indian Navy P-8I carrying inert Harpoon AShMs during pre-delivery testing in the USA (photo: Clemens Vasters)

The three Project-15 *Delhi*-class 6,700-tonne DDGs, commissioned between 1997 and 2001, will also stable the BrahMos once these ships are modified and upgraded. While INS *Rajput* will be armed with four BrahMos, INS *Ranvir* will have eight, apart from two and four SS-N-2D Styx ASHMs respectively. BrahMos can also replace the Russian 3M-54 Klub ASHMs on the three 5,300-tonne Project 17 *Shivalik*-class stealth multi-role frigates.

The maiden test firing of the submarine-launched BrahMos variant was carried out vertically in March 2013 from a submerged platform. BAPL CEO and Managing Director SK Mishra describes the firing as “the very first time a supersonic cruise missile, in its full operational configuration, was test-fired vertically from an underwater platform, with the test being a 100 per cent success.” The canisterised missile, installed in a modular launcher in the pressure hull of a submarine, is launched vertically from underwater depths of 40 to 50 m. This will greatly add to the ‘offensive power’ of the vessel without compromising on its ‘defensive power’ as the torpedo tubes can be fully utilised for defence.

The six 1,565-tonne Project-75 *Scorpene*-class SSKs, being built indigenously under transfer of technology from French shipbuilder DCNS, will be equipped with the SM39 Exocet ASHM that can be launched from its six 533 mm torpedo tubes. Built by European missile firm MBDA, the high subsonic 4.7 m long, 350 mm-

diameter, 655 kg ASHM has a range of 50 km, can attain speeds up to Mach 0.9 and can carry 165 kg high-explosive conventional warheads. Though launched in a watertight VSM (*véhicule sous marin*) capsule through the torpedo tubes, once in the air, the missile behaves like a standard Exocet with its sea-skimming and manoeuvring advantages. The launch vessel is difficult to locate as the missile exits the water some distance from it and also does not require the submarine to rise to periscope depth for the launch. INS *Kalvari*, the first *Scorpene* boat, was launched in October 2015 and will be commissioned shortly, with subsequent boats delivered at intervals of nine months.

It is likely that the Exocet and, of course, the BrahMos will be deployed also on the proposed six Project-75(I) new generation stealth diesel-electric submarines, the global tender or RFP (Request For Proposal) for which is yet to be issued.

BAPL is working on a smaller lighter variant of BrahMos with the same operational range and payload, but only 6 m. in length and 1.4 tonnes in weight. Named BrahMos-NG (next generation), it is to incorporate the best of cruise missile technology and will be carried by new-generation military platforms, including warships, submarines and fighter aircraft. Its first flight test is expected to be conducted in the next three to four years, before production is taken up.

The six 1,250-tonne next-generation missile boats that are proposed to be

constructed in India as ‘pocket battleships’ will also be armed with BrahMos. These all-new boats will replace the Navy’s ageing *Prabal*-class missile boats and will also be equipped with surface-to-air-missiles, close-in-weapon systems for missile interception, a main gun and point-defence guns.

Similar success however is eluding *Nirbhay* (‘fearless’), India’s first indigenously designed and developed long-range subsonic cruise missile, that can reach targets up to 1,000 km away and can carry nuclear or conventional warheads weighing 300 to 400 kg. This two-stage missile, designed and developed by the Ministry of Defence’s (MoD’s) Defence Research and Development Organisation (DRDO), is primarily a land-attack missile, but can be converted to an anti-ship variant with ease by adding additional guidance software and hardware. However, a recent test firing in October 2015 was but a partial success, as the missile, supposedly India’s equivalent of the US Tomahawk, developed technical snags and its flight had to be aborted as it could not maintain altitude. During its maiden test in March 2013, the missile encountered a similar hitch and was destroyed mid-trajectory. An MoD statement, however, indicated that all initial critical operations such as booster ignition, booster separation, wing deployment and engine start had been successfully executed and *Nirbhay* had reached the desired cruise altitude.

Powered by a solid rocket booster, the 6 m missile, with a diameter of 0.5 m, wing span of 2.7 m and launch weight of 1.5 tonnes, lifts vertically as a rocket and after the first stage separation, cruises like an aircraft. It can reach a speed of up to Mach 0.9 at altitudes 500 m and 4 km above the sea or ground and also at ‘tree-top level’ to avoid detection by enemy radar. The Tomahawk, in turn, is the most widely used cruise missile that came into its own in the first Gulf War of 1991, but the gap between cruise missiles and anti-ship missiles is narrowing as technology advances.

Nirbhay’s system incorporates a ring laser gyroscope based inertial navigation system (RINS-16) as primary navigation and micro-electromechanical systems (MEMS) based inertial navigation system (MINGS) as secondary navigation system. It can be launched from multiple platforms, including ships and submarines, aircraft and land-based vehicles/launchers and will be inducted by all the three services.



An AM39 Exocet missile

Both Nirbhay and BrahMos are very flexible and can be launched from any Indian Navy platform fitted with the UVM. But, whereas Nirbhay can be intercepted with an appropriate SSM, once detected, the BrahMos is virtually impossible to fend off unless with a fully automated protection system of anti-missile radar-gun-missile combination. BrahMos is also brutal-impact owing to its very high velocity that packs 32 times the kinetic energy of the Tomahawk, while Nirbhay's versatility is in its ability to carry 24 different types of payloads.

A medium-range submarine launched ballistic missile (SLBM) – variously christened Sagarika, K-15 and Dhanush, and finally codenamed BO5 – has been developed by DRDO and is being produced specifically for India's first indigenous SSBN, INS *Arihant*, which was commissioned in August 2016. The BO5/K-15 will provide retaliatory nuclear strike capability and forms a part of India's nuclear triad. The 6,000 tonne *Arihant* is the first of a series of three SSBNs and measures 110 m in length and 11 m in breadth. The two follow-ons will both be larger and more advanced.

Each of these ballistic missile submarines can carry 12 of these 6.3-tonne, 10.4 m long and 1 m-diameter SLBMs that can be launched from even under ice caps, and can carry a nuclear warhead of up to a tonne to a range of 750 km. An underwater missile launcher was developed in 2001. The missile was first test-fired from a submersible pontoon launcher in 2007 and trials for its integration with the submarine began in 2009. A prototype was successfully test fired last November from *Arihant*, which also conducted the maiden test in March of a greatly advanced indigenous SLBM, codenamed K-4, which carried a dummy payload. Both the solid-fuelled medium range BO5 K-15 and intermediate range K-4 are from the 'K' series of SLBMs being developed by DRDO. The *Arihant*-class submarines will also be able to stow four of the 17-tonne K-4s that are 12 m long, 1.3 m in diameter and can carry a 2-tonne payload to targets 3,500 km away.

The Indian Navy has other missile imports apart from the Exocet. An abiding client for Soviet weaponry, India has various Russian-made cruise missiles in its inventory like the 3M-54E Klub (SS-N-27 *Sizzler*), Kh-35 Uran/3M-24 (SS-N-25 *Switchblade*) and Kh-31 (AS-17 *Krypton*). The Indian Navy was the first customer of the anti-

ship/anti-submarine/land-attack 3M-54E Klub, a new series of short-range ASHMs from the Novator Design Bureau. India's six *Talwar*-class FFGs and the three *Shivalik* class frigates operate the 3M-54E Klub-N, the version launched from surface vessels and which can be installed in vertical launch cells or in angled missile boxes. Klub-S is launched from submarines, though what distinguishes the two versions is the design of the missile launchers and missile transport-launching containers.



Indian Navy MiG-29K showing armament load, including two Kh-35 ASHMs on the inboard pylons (photo: Angad Singh)

India has inducted a large number of the 1.5-tonne Klub, which can deliver a 450 kg payload across 300 km. The weapon is powerful enough to disable even an aircraft carrier and its moderate weight allows its placement on even compact warships. Apart from its frigates, the Indian Navy has deployed the missile also on its Type 877EKM *Sindughosh*-class (*Kilo*-class) diesel-electric submarines. An air-launched version is reportedly under development, and it is likely that the Indian Navy's long-range, maritime patrol aircraft could eventually be armed with it.

The Kh-35 Uran, from the Tactical Missile Corporation, arms the Indian Navy's two 3,850-tonne *Brahmaputra*-class frigates – the third, INS *Betwa*, having been irreversibly damaged on 5 December while undergoing refit – and three *Delhi*-class destroyers. Each of these classes houses 16 of these missiles in four quadruple KT-184 launchers, angled at 30 degrees, two on either side of the bridge superstructure. All 16 Urans can be ripple-fired in 2 to 3 second intervals. Equivalent to Boeing's Harpoon Block 1C ASHM, these missiles have active radar homing (ARH) of a 130 km radius at 0.9 Mach, with a 145 kg warhead.

The multi-role MiG-29K fighter aircraft being inducted by the Indian

Navy will be armed with both the Kh-31A and Kh-35E ASHMs along with the Kh-31P anti-radar missiles. Again, some 100 of these missiles were ordered by the Indian Navy in 1997, also for deployment on its Ilyushin Il-38SD aircraft and Sukhoi Su-30MKI multirole air superiority fighter. The 4.7-m long and 610 kg Kh-31A carries a 94 kg warhead up to 70 km and skims the sea as it approaches targets. Meanwhile, the Kh-31AD with 110kg warhead is offered for

export with an improved range of 160km when launched at high altitude.

India is also planning to equip its *Shishumar*-class (HDW) submarines with Harpoon missiles, the world's most successful ASHM that is in service with the armed forces of over 30 countries and which currently arms the Indian Navy's fleet of eight Boeing P-8I ASW aircraft. Upgraded over the years and now available as the all-weather, over-the-horizon, anti-ship and land-strike Harpoon Block II, four of these missiles are carried by each P-8I.

Built in the 1970s by McDonnell Douglas, which merged with Boeing in 1997, the Harpoon has a low-level sea-skimming cruise trajectory and incorporates key guidance technologies from two other Boeing weapons programmes – the low-cost integrated GPS/INS (global positioning system/inertial navigation system) and the software, mission computer, GPS antenna and receiver from the SLAM-ER (standoff land attack missile-expanded response). For conventional anti-ship missions, the GPS/INS improves mid-course guidance to the target area, while the accurate navigation solution helps distinguish target ships from islands or other nearby landmasses or ships.

Sarosh Bana, CLAWS



Air Wing of the

Future Supercarrier

Aviation element of the US Navy's new 'Gerald R Ford'-class carriers

At the *EuroNaval* show in October 2016, this *Vayu* correspondent came across a model of the United States Navy's new generation *Gerald R Ford*-class aircraft carrier, proudly displaying the futuristic General Atomics Electro-Magnetic Aircraft Launch System (EMALS), capable of launching all types of carrier assets from Airborne Early Warning & Control (AEW&C) platforms through multi-role fighters to Unmanned Combat Aerial Vehicles (UCAVs). Not surprisingly to this writer, the air wing of the lead warship *Gerald R Ford* (CVN-78) displayed models of combat proven aviation assets, namely the Boeing F/A-18E/F Super Hornet multi-role strike fighter and the Northrop Grumman E-2C/D Hawkeye/Advanced Hawkeye Airborne Early Warning & Control System (AEW&C) platform for assured protection and strategic plus tactical power projection. Newer platforms are likely to complement

the combat proven ones in the foreseeable future.

The 'strike-oriented heavy duty' multi-mission F/A-18E/F Block II Super Hornet is an upgrade of the combat-proven night-strike F/A-18C/D that provided the US Navy with a platform that has range, endurance, and ordnance carriage capabilities comparable to the A-6 Intruder 'heavy-duty' strike platform and, as per manufacturer claims, incorporates lower Radar Cross Section (RCS) technology and other survivability enhancements from the outset. Still it is reasonable to deduce that survivability of the Super Hornet platform chiefly rests on excellent combat proven AN/ALQ-124 Integrated Defensive Countermeasures system (IDECM) system that includes the ALE-47 countermeasures dispenser, the ALE-55 towed decoy (which can transmit jamming signals based on data received from the IDECM) and the

AN/ALR-67(V)3 Radar Warning Receiver (RWR) providing coordinated situation awareness and managing the on-board and off-board deception countermeasures, expendable decoys, plus signal and frequency control of emissions.

The US Navy inducted the first operational F/A-18E/F squadron (VFA-115) in September 2001, with Super Hornets deployed on board the USS *Abraham Lincoln* (CVN-72) in July 2002. 'Baptism by fire' followed shortly thereafter when, in November 2002, the aircraft made its combat entry, striking at air defence installations in Southern Iraq with the Global Positioning System GPS-guided JDAM. Subsequently the aircraft was also deployed as part of *Operation Iraqi Freedom* in March 2003, and has seen extensive combat employment since.

F/A-18E/F aircraft are of larger size than earlier Hornets, with bigger wing

area, and thereby carry more internal fuel for effective increase of mission range by 41% and endurance by 50% (can be further enhanced with in-flight refuelling procedures and 'combat-rated' drop tanks). Their high fuel-fraction in combination with greater weapons-load enable Super Hornets to make fewer sorties into the target area and employ more 'dogs legs' or tactically desirable routes, resulting in less threat exposure and enhanced survivability. For the same reason, the aircraft carries the complete complement of 'smart' air-to-ground weapons, including the newest precision-GPS/inertial-guided family of joint weapons such as Joint Direct Attack Munitions (JDAM), Joint Stand-Off Weapon (JSOW) and Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM), so as to stay out of the heaviest ground-based defences while performing the strike role and decimating counterforce infrastructures. A total of 8,000 kg of external load including nuclear and conventional ordnance and associated sensors are carried on eleven weapon stations including two additional wing store stations.

Two General Electric F414-GE-400 turbofan engines provide the Super Hornet with combined thrust of 44,000-pounds thrust in afterburner. Its nine-to-one thrust-to-weight ratio is one of the highest of any modern fighter engine extant, seen as necessary in order to retain air combat potential even with significant strike payload.



An F/A-18F 'buddy-refueling' an F/A-18C 'Legacy Hornet'

In the subsonic regime, the performance of F/A-18E/F is "at par or better than" the basic F/A-18C/D. At high Angles-of-Attack (AoA) the symmetrically loaded F/A-18E/F boasts superior roll performance and better handling characteristics in absence of AoA limitations. The F414 combines advanced technology with the proven design base of its F404 predecessor. Design priority was accorded to critical features such as durability, reliability, and easy maintenance. The engine entered production in late 1998, and has accumulated in excess of 3,000,000 flight hours, having entered

operational service in the year 2000 on USN F/A-18E/F Super Hornets. Latest materials and cooling techniques allow for higher temperatures and pressures without sacrificing component life. The F414 consists of six fully interchangeable modules for easy maintenance while an In-flight Engine Condition Monitoring System (IECMS) keeps pilots informed about engine parameters, allowing them to take action if necessary.

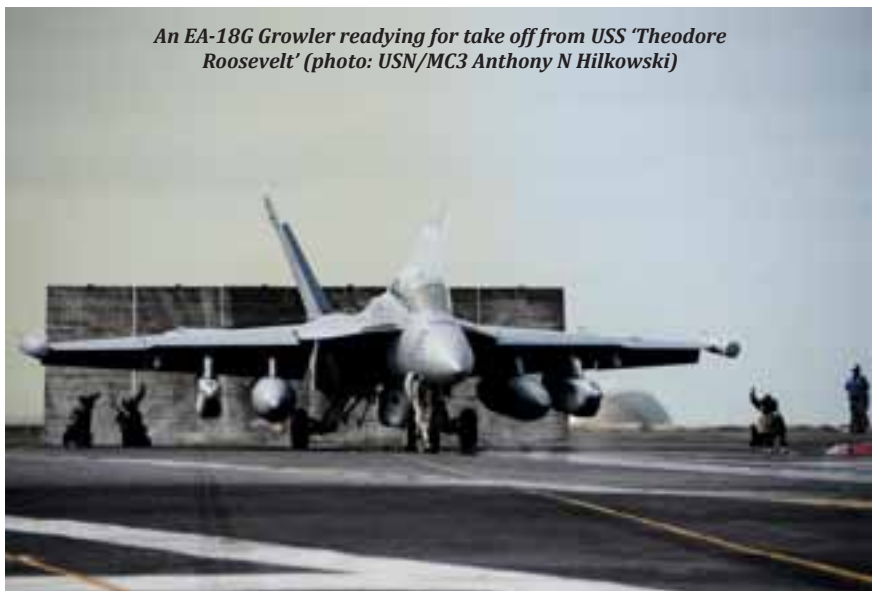
Primary Sensor

The Super Hornet's primary sensor is the Raytheon AN/APG-79 Active Electronically Scanned Array (AESA) radar, the building block of which is Gallium Arsenide (GaAs) Monolithic Microwave Integrated Circuit (MMIC) using lithographic-type processes to produce microwave circuits on chips at very high levels of integration. The light antenna, with the array weighing only 95-pounds, reportedly has an extremely low failure rate requiring little to no maintenance over decades. The AN/APG-79 radar enables air-to-air target detection and tracking at long ranges and provides higher resolution Synthetic Aperture Radar (SAR) air-to-ground mapping while itself remaining largely immune to Electronic Counter Measures (ECM), interference, and interception. The radar can interleave air-to-air, air-to-ground and terrain following modes to provide simultaneous assessment in every mode, a highly desirable attribute for a strike fighter in terms of situational awareness. The AN/APG-79 AESA entered low-rate initial production in September



A Super Hornet in flight over its parent carrier (photo: US Navy)

An EA-18G Growler readying for take off from USS 'Theodore Roosevelt' (photo: USN/MC3 Anthony N Hilkowski)



2003 and was integrated with new-build Block II Super Hornets from 2005 onward, while older Block I Super Hornets were retrofitted in later years.

Raytheon's AN/ASQ-228 ATFLIR (Advanced Targeting Forward-Looking Infra-Red) is deployed for "silent nocturnal approach," and features both navigation and infrared targeting systems, in particular a third-generation Mid-Wave (3-5 micron) Forward Looking Infra-Red (MWFLIR) for targeting purposes and incorporating staring focal plane array technology. The ATFLIR complements the Super Hornet's AESA primary sensor. Additional sensors in the 'package' include a high-powered diode-pumped laser spot tracker, navigation FLIR and Charged Coupled Device (CCD) TV camera. Standard reconnaissance hardware is the Raytheon Shared Reconnaissance Pod (SHARP). Additionally, an electronic attack version of the Super Hornet, the EA-18G Growler, modified for escort and close-in jamming incorporating the Improved Capability III (ICAP III) suite developed for the EA-6B Prowler accompanies F/A-18E/F in strike missions to deal with enemy air defence network and installations.

The Super Hornet is well suited for emerging naval and littoral operations. For anti-ship strike AGM-84 Harpoon is carried as also its land attack variants, the Stand-off Land Attack Missile (SLAM) and its extended range variant the SLAM-ER. The AGM-84D Harpoon anti-ship missile was first introduced in 1977 and has undergone numerous upgrades to represent "cutting-edge technology." Presently the

latest air launched anti-ship variant is the AGM-84D Block 1C with further developments constantly being evaluated to ensure survivability of the missile type for perhaps another decade. The missile maintains a deadly sea-skimming run monitored by a radar altimeter and can execute a deceptive sudden 'pop-up manoeuvre' at the terminal phase with guidance provided by an Active-Radar Homing (ARH) seeker. Substantial damage is caused by the penetrative high-explosive (Destex) 215-pound warhead.

While the Harpoon promises to be a formidable destructive weapon, its importance lies in its progressive development to land-attack variants in response to demands for an effective weapon in emerging littoral warfare scenarios. Taking advantage of the extensive technological base that the United States possesses in the field of missile technology, Harpoon AGM-84E Block 1E Stand-Off Land Attack Missile (SLAM) was developed as an enhanced range weapon system for precision strike capability against high value land targets and ships in port, by amalgamating proven technology from other missile systems. The guidance system was modified with an Inertial Navigation System (INS) with Global Positioning System (GPS). Infra-Red (IR) terminal guidance was derived from AGM-62 Walleye (a highly successful Vietnam War-era munition), the data-link feature of AGM-65 Maverick was incorporated and it is fitted with a Tomahawk warhead for better penetration.

Further upgrade potential became inherent in the process and this materialised in the form of AGM-84E Block 1F SLAM-ER (Expanded Response). The Missile's range was enhanced to nearly 300 km with formidable target penetration capability, thanks to the titanium warhead. Another significant attribute was enhancement of control range, which in combination with software improvements allows the pilot to retarget the impact point of the missile even during the terminal phase of attack. In February 2004, the SLAM-ER completed integration on the USN P-3C Orion and all USN SLAM missiles are being retrofitted to the SLAM-ER configuration. Still under development is the AGM-84E Block 1G SLAM-ATA (Automatic Target Acquisition) with re-attack capability and new seeker, perhaps a Digital Scene Matching Area Correlator (DSMAC). Variants of SLAM-ER/ATA appear to be capable of conducting successful counterforce operations against enemy high value assets including nuclear infrastructures by conventional strikes alone (a significant advantage) yet stay clear from anticipated heaviest enemy ground-based defences.

The Harpoon Block II presently in production is intended to offer an expanded engagement envelope, enhanced resistance to Electronic Counter Measures (ECM) and improved targeting in littoral waters. The key improvements of the Harpoon Block II are obtained by incorporating the Inertial Measurement Unit (IMU) from the JDAM program, and the software, computer, GPS/inertial navigation system and GPS antenna/receiver from the SLAM-ER.

For BVR combat, including cruise missile interception in concert with suitable AEW&C platforms, the AN/APG-79 AESA radar is crucial to Super Hornet operations. F/A-18E/F fleets operating alongside F-22 Raptor and F-35 Lightning II fleets at middle altitudes around 25,000-30,000-ft "at different layers" are projected to operate in an extended picket line to track cruise missiles from the "less stealthy" beam aspect. The primary weapon under such circumstances is projected to be a specific variant AIM-120C AMRAAM, the AIM-120C-6 with an improved seeker and an updated TDD (Target Detection Device) to optimise the explosive cone of destruction for small, slow targets in a head-on engagement and incorporates improved fusing through a new quadrant target-

detection device. The “set-piece moves” of the USAF and USN fighters including Super Hornets include approach to a wave of cruise missiles head-on, get in a first shot and then turn for a second and third shot from behind. The follow-on AIM-120C-7 (P3I Phase 3) incorporates improved Electronic Counter-Counter Measures (ECCM) with jamming detection, an upgraded seeker, and longer range. The AESA set in addition with secure, interoperable technology can also be modified to send and receive large amounts of information at extremely high data rates with minimal “leakage” to force multipliers such as AEW&C platforms, UAVs and ground stations to enhance situational awareness.

Close-Combat

Close-combat effectiveness and punch is further provided by incorporation of the Boeing-developed Joint Helmet-Mounted Cueing System (JHMCS) and Raytheon AIM-9X Sidewinder close-combat missile. The AIM-9X uses an extremely agile thrust-vector controlled airframe along with a mature staring focal plane array IR sensor to facilitate extremely high off-boresight acquisition and launch envelopes, greatly enhanced manoeuvrability and improved target acquisition ranges to provide a ‘first shot – first kill’ advantage. For future enhancements, the digital design architecture of the missile provides inherent growth capability. An Infra-Red Search and Track (IRST) sensor, the IRST21 is entering service, mounted on a modified centreline fuel tank to provide additional “silent” support to AIM-9X. For ‘eyeball to eyeball confrontation’ the gun system is General Dynamics M61A2, with a selectable firing rate of 4,000 or 6,000 shots per minute.

AEW&C

For ‘guidance’ to the F/A-18E/F Super Hornet fleet, the Northrop Grumman E-2D Advanced Hawkeye AEW&C platform successfully meets the parameters regarding presentation of an integrated air and surface picture of the area under surveillance in adverse weather conditions and in dense electronic environment, airborne surveillance, detection and tracking of both airborne and surface contacts and control of air interceptions and air strikes. After all, for assured protection of aircraft carrier strike groups, the attacking airborne missile platforms need to be destroyed well before their munitions are released. Fixed-wing AEW&C platforms have superior coverage of airspace and more importantly have the ability to guide and control shipborne fighters towards their targets, both in air defence and strike missions, an attribute lacking in the Airborne Early Warning (AEW) helicopter platforms.

The ancestry of the E-2D of course dates back to E-2A variant, which gained operational status over 50 years ago aboard the USS *Kitty Hawk* (CVA-63) in 1965, giving the E-2 the longest production run of any carrier-based aircraft. During the Vietnam War Hawkeyes initially operated in support of USN F-4 Phantoms and F-8 Crusaders performing armed Combat Air Patrol (CAP) to cover strike elements. Subsequently Hawkeye platforms started to control strike missions, guiding USN strike packages of F-4 Phantoms and A-6 Intruders around high ground and defensive concentrations, and warning them of enemy interceptors in the vicinity. However the primary role of the E-2 Hawkeye is to operate as an all-weather AEW&C platform

to the naval task force capable of area and on-station search. From an operating altitude of 25,000 to 30,000 ft, the Hawkeye warns the naval task force of approaching air threats and provides threat identification and positional data to interceptors. Secondary roles include strike command and control, surveillance, guidance of search and rescue missions including support for anti-hijack operations and as a relay to extend the range of communications between the airborne platforms and the Combat Information Centre (CIC) of the parent aircraft carrier.

The E-2C with the APS-120 radar made its operational debut with VAW-123 aboard USS *Saratoga* bound for the Mediterranean Sea in September 1974. This version was first to acquire a decent ‘over-land’ capability. A Hawkeye is usually one of the first aircraft to leave a carrier’s deck after commencement of air operations, and the fuselage is designed for carrier operations, fitted with a catapult attachment for accelerated carrier take-off, an A-frame arrestor hook for engagement of the arresting gear and a tail bumper to withstand impact or scraping on the runway. At on-station search mode the E-2C flies at around 25,000 to 30,000 feet at a distance of 370 km from the parent carrier in a constant orbit, gaining altitude steadily as fuel burns off. The flaps are set at 10-degrees to provide the optimum 3-degrees radar-scanning attitude. The new Allison T56A-427 engines, each rated at 5,100-shaft horsepower, allow the E-2C to cruise on station for more than four hours.

During the 1990s the then recently introduced APS-138 advanced radar processing system enabled detection, identification and tracking both over land and sea in excess of 450 km and with expanded computer memory was able to accomplish triangulation automatically. Advanced passive detection enabled ‘silent’ recognition and classification of hostile electronic emissions at ranges well in excess of the on board radar. A pair of Litton L-304 computers handled data processing. Data inputs or request for information were made either by means of an alphanumeric keyboard or by a light-pen which was usually used to ‘hook’ a specific USN F-14 Tomcat interceptor to a specific target by feeding relevant target information to the interceptor weapons control system by means of a data-link. The developing tactical situations were presented by means of the Hazeltine APA-172 control indicator group



An E-2D Advanced Hawkeye seen with wings folded on the deck of USS Theodore Roosevelt (photo: Angad Singh)

to the mission control room located in the rear fuselage directly beneath the radome and included the Combat Information Centre Officer (CICO), Air Control Officer and the Radar Operator on identical crew stations of 10-inch diameter main radar display screens, providing data pertaining to target tracks and 5-inch alphanumeric auxiliary display. Independent control at each station enabled crewmembers to select relevant information and data to be presented including target symbols, velocity vectors, and disposition of friendly fighter forces, surface task groups and waypoints. The CICO remained in radio contact with the air defence commander, usually stationed on a *Ticonderoga*-class Aegis missile cruiser and if the CICO encountered a radar hit that was not sending out aircraft-identification signals from an on-board transponder, the E-2C's Air Control Officer zoomed in on the inbound track and passed the relevant data to the air defence fighters and interceptors engaged in CAP duty.

Presently the 24-ft diameter radome houses the AN/APA-171 antenna supplied by Randtron Systems rotating at a rate of five to six rpm. The Lockheed Martin AN/APS-145 radar is capable of tracking more than 2,000 targets and controlling the interception of 40 hostile targets. One radar sweep covers 6 million cubic miles. The radar's total radiation aperture control antenna reduces sidelobes and is sufficiently robust against Electronic Counter Measures (ECM). It is now capable of detecting hostile airborne targets at ranges greater than 550 km, and even cruise missiles with Radar Cross Section (RCS) of 1 sq m or less can be detected at around 185 km. This serves as a critical advantage as even hostile submarines are likely to attack with sea-skimming anti-ship missiles and cruise missiles, thus ASW screening becomes analogous to air defence and often the mere presence of incoming cruise missiles will serve as the only warning of an impending attack.

The latest mission computers are equipped with an enhanced high-speed parallel processor. The Lockheed Martin AN/UYQ-70 advanced display system and computer peripherals provide the operators with multi-colour displays, map overlays, zoom facilities and auxiliary data displays. In August 2005, Northrop Grumman completed the E-2C mission computer replacement programme, with the provision of faster, more powerful and

reliable computers. The communications suite includes an AN/ARC-158 Ultra High Frequency (UHF) data link, an AN/ARQ-34 High Frequency (HF) datalink and a Joint Tactical Information Distribution System (JTIDS).

The current-generation standard E-2C 'Hawkeye 2000' made its first operational deployment in 2003 aboard USS *Nimitz* in support of *Operation Iraqi Freedom*. The Hawkeye 2000 features a smaller and lighter Raytheon Mission Computer Upgrade (MCU) based on open architecture commercial off-the-shelf (COTS) technology, with increased memory and faster processing. More importantly Co-operative Engagement Capability (CEC) consists of processor, data distribution system and antenna and to enable Hawkeye 2000 to perform real-time Battle Management (BM), fusing and distributing information from sources such as satellite and ship-borne radar. Also included in the "package" are Lockheed Martin Advanced Control Indicator Set (ACIS), Satellite Communications (SATCOM) and pristine navigation and flight control systems while Electronic Support Measures (ESM) equipment has been upgraded. From May 2004 onwards, USN Hawkeye 2000 aircraft are being fitted with Hamilton Sundstrand NP2000 digitally controlled eight-bladed propellers.

E-2D Advanced Hawkeye

The Hawkeye meanwhile remains well within its development cycle with development proceeding on the next-generation E-2D Advanced Hawkeye with emphasis on Battle Management Command and Control (BMC2) capable of serving as a 'digital quarterback' to sweep ahead of strike missions, manage aircraft, and keep net-centric carrier battle groups out of harm's way. Having attained Initial Operational Capability (IOC) in October 2014, the E-2D is fitted with Lockheed Martin Maritime Systems and Sensors-developed sophisticated AN/APY-9 next-generation solid-state, electronically steered Ultra-High Frequency (UHF) radar with new Electronically Scanned Array (ESA) antenna (Northrop Grumman supplies the transmitter, Raytheon the receiver, L-3 Communications Randtron the UHF antenna and BAE Systems CNIR the IFF system) that supports Advanced AEW Surveillance (AAS), Enhanced Sector

Scan (ESS) and pure electronic scanning Enhanced Tracking Sector (ETS) radar modes performing 360-degrees scanning allowing flight operators to focus the radar on select areas of interest (including targets in air and sea surface simultaneously), Space-Time Adaptive Processing (STAP) software, enabling the hybrid AN/APY-9 ESA radar to pick small Radar Cross Section (RCS) flying targets out of a background of rough terrain and urban sprawl, digital receivers, plus Adaptive Detection System (ADS) -18/Rotary Coupler Assembly (RCA) with co-aligned advanced Identification Friend or Foe (IFF).

The range of AN/APY-9 may be deduced to be at least at 400 km, more likely to be limited only by the E-2D radar horizon. The radar significantly enhances Theatre Missile Defence (against TBMs) plus air defence capabilities in the littorals, overland and open sea, thanks further to multi-sensor integration and a Northrop Grumman Navigation Systems fully integrated 'all glass' tactical cockpit for expanded battlespace awareness. To spread the workload, the new design gives the co-pilot a scope of his own so he can participate in the E-2D's tactical mission when he is not helping fly the platform.

Added E-2D features include Electronic Support Measures (ESM) enhancements in form of AN/ALQ-217, new mission computer and tactical workstations with the Combat Information Centre (CIC) is equipped with 20-inch diagonal Active Matrix Liquid Crystal Display (AMLCD) supporting 8-bits per colour RGB and 256 shades of grey with wide viewing angle (± 75 degrees horizontal and $+40$ degrees/ -30 degrees vertical), and modernised communications and data-link suite. The operating height of 25,000 ft above forward-deployed fleets will enable the E-2D's AN/APY-9 radar to detect hostile incoming missiles at ranges great enough to allow for organisation of an effective fleet defence, while the slow 474-km/hr cruise speed is bound to maximise target observation time, to collect airborne target and electronic emitter data from well beyond the radar horizon of surface ships. The E-2D can then feed this to fighter aircraft, shipboard missile defences and the newly emerging Global Information Grid (GIG). In the more conventional role of 'maritime sentinel,' E-2Ds will be able to communicate directly with aircraft carrier battle groups, fighter



The present and future of US Navy strike fighters: the F-35C will complement the F/A-18E/F on future USN carriers (photo: US Navy)

aircraft, communications satellites, UAVs, submarines, Search and Rescue (SAR) platforms and C&C centres. Improved Rolls-Royce T56-A-427A engines feature a propulsion system control, monitoring and maintenance system along with emergency power rating to increase single-engine rate of climb. Hamilton Sundstrand NP2000 digitally controlled, eight-bladed propellers provide less vibration and noise. An in-development in-flight refueling capability will extend mission endurance to twelve hours.

Projected to replace all 75 USN E-2C AEW&C platforms, the first System Development & Demonstration (SD&D) E-2D (Delta One) made its maiden flight on 3 August 2007 with Northrop Grumman Flight Test Pilot Tom Boutin and USN Flight Test Pilot Lt. Drew Ballinger along with Northrop Grumman Flight Test Lead Weapon Systems Operator Ziad Hajo. On 30 July 2010, the first production E-2D was transferred to the USN's Airborne Early Warning Squadron VAW-120 based in Norfolk. On 3 February 2011, an E-2D assigned to Air Test and Evaluation Squadron 20 (VX-20) landed on the eighth *Nimitz*-class carrier USS *Harry S Truman*

(CVN 75) to initiate carrier suitability testing. IOC was attained in October 2014 with VAW-125 aboard USS *Theodore Roosevelt* (CVN-71), and on 11 March 2015, the *Theodore Roosevelt* Carrier Strike Group departed Naval Station Norfolk and returned to port on 23 November 2015, concluding the first operational use of the E-2D.

Additionally, in USN operations the E-2D will be the first platform in the distributed missile defence network to detect a cruise missile launched from a ground-based mobile platform. Responding to this time-critical threat, the E-2D, utilising FORCEnet-enabled communications, will alert a *Ticonderoga*-class Aegis cruiser of the launch and will provide continuous cueing information until the Aegis can destroy the missile. Simultaneously, collaborating with satellite Intelligence, Surveillance, and Reconnaissance (ISR) assets, the E-2D will direct an UAV to precisely locate and identify the launch platform. As the airborne battle manager, the E-2D will relay this information to strike aircraft to deliver precision-guided weapons to eliminate the launcher before it can reposition or launch a second attack.

USN's Transformation

With a two-generation leap in radar technology and improved data processing and communications the E-2D is the foundation for Theatre Air Missile Defence, a key element in the 'Sea Shield' portion of the USN's 'Sea Power 21' transformation plan. In addition, the system fulfils an ever-expanding role in 'Sea Strike,' with improved detection and tracking capability in littoral and overland operations. Utilising its open-architecture network connectivity, it is a key FORCEnet enabler and provides the ability to coordinate time-critical targeting and time-critical strike operations. The Hawkeye's performance in *Operation Enduring Freedom* and *Operation Iraqi Freedom* demonstrated how dynamic and flexible the weapon system is in a joint force battle engagement.

Undoubtedly the E-2D Advanced Hawkeye is critical in the transformation of combat elements to a fully networked joint combat force, providing airborne battlespace command and control well into the 21st century.

Sayan Majumdar

First Rafale for Qatar



The first single-seat Rafale EQ built for the Qatar Emiri Air Force (serial EQ01) has flown, the aircraft painted in a new camouflage scheme, at Dassault's airfield in Bordeaux-Mérignac. France and Qatar had signed the deal for 24 Rafales at Doha in May 2015, including training for 36 pilots and 100 engineers. A twin-seat example for Qatar (DQ01) has been used to test the new TARGO II helmet-mounted cueing system from Elbit. Another trials aircraft has recently been engaged in testing from Istres with a Lockheed Martin Sniper advanced targeting pod. The €6.7bn deal included an unspecified package of weapons from MBDA with deliveries due from mid-2018. A further 12 Rafales for Qatar are an option.

More F-16s for Indonesia



Another batch of four more refurbished and upgraded Block 25 F-16C/Ds have been delivered to the *Tentara Nasional Indonesia-Angkatan Udara* (TNI-AU, Indonesian Air Force). The latest four aircraft (comprising three F-16Cs and one F-16D) were upgraded by the Ogden Air Logistics Complex, and were former US Air Force and Air National Guard aircraft in storage at the 309th Aerospace Maintenance and Regeneration Group at Davis-Monthan AFB, Arizona. Indonesia has ordered a total of 24 F-16C/Ds.

More F-15s for Israel



According to reports from Tel Aviv, the Israeli Air Force plan to purchase additional batches of F-15 aircraft from the United States, including a 'squadron's worth' of advanced F-15s, and either CH-53K or CH-47 helicopters to replace existing CH-53 *Yasur* aircraft. In related news, the Israeli Air Force have struck targets using F-15I fighters against "high value assets" in Syria. During the raid, they faced SA-5 *Gammon* surface-to-surface air missiles launched against them and one SAM was shot down by an Israeli Arrow 2 anti-ballistic missile system, making its combat debut.

Additional A-29s for Afghanistan



Another batch of four A-29s Super Tucanos for the Afghan Air Force (AAF) were delivered to the Kabul Air Wing on 20 March, increasing the AAF's inventory to 12 such aircraft, while another seven A-29s are still assigned to Moody AFB for pilot training. Brig Gen David Hicks, Train, Advise, Assist Command-Air (TAACAir) and 438th Air Expeditionary Wing Commander, described the A-29s as a "game changer...The AAF pilots are continually gaining proficiency in the A-29 and are capable of providing air attack anywhere in the country".

Increased Japanese fighter interceptions



The Japan Air Self-Defense Force (JASDF) have increased the number of fighters assigned to airspace defence missions, now scrambling four jets for each interception of a potential airspace violation. The previous Japanese quick reaction alert (QRA), had two fighters intercepting potential intruders. The change in policy comes at a time of increased Chinese military activity around the Senkaku Islands in the East China Sea. The extra JASDF aircraft are required to monitor any additional aircraft that join the incursion, suggesting that China is regularly deploying larger formations in the East China Sea. The JASDF has also extended the duration of its combat air patrols and increased the number of sorties by E-2C early warning aircraft.

First Egyptian MiG-29M2



The first MiG-29M2 for the Egyptian Air Force has flown at Zhukovsky near Moscow, and is one of an initial three production examples being manufactured for flight testing. Egypt had ordered 46 MiG-29M and M2 two-seat trainers in April 2015. This enigmatic fighter has two designations, MiG-29M and MiG-35, the latter essentially as marketing strategy, with the Indian Air Force having been the first target customer during the M-MRCA evaluation.

L-159T for Iraqi AF



After thirteen years, Aero Vodochody has completed the first two-seat L-159T to be built on its production line, the aircraft handed over to the Iraqi Air Force on 31 December 2016, but being retained to help train Iraqi pilots. The Iraqi Air Force has ordered 12 L-159s, of which ten single-seaters have already been delivered and are based at Balad Air Base.

Additional F-16s for Bahrain



The much delayed sale of an additional 19 F-16s to Bahrain is likely to shortly receive clearance. On 29 March, the US Foreign Relations Committee was notified by the State Department that the new administration intends to approve the sale for 19 aircraft, the package including 23 engines, radars and avionics, weapons and other related equipment. This Bahraini order will extend the F-16 production line, which was otherwise due to cease work in August or September and is reportedly moving from Fort Worth to a new facility in North Carolina.

Meanwhile, according to recent reports, the Romanian Air Force is to procure another 20 F-16s. Romania will have received 12 F-16s by the end of this year via OGM (*Indústria Aeronáutica de Portugal SA*), comprising nine F-16AM single-seaters and three F-16BM two-seaters under the *Peace Carpathian* programme. Increased funding also meets Romania's NATO commitments. Meanwhile, F-16 sales continue, with the Iraqi Air Force receiving its fifth batch of four F-16IQs on 24 March for the 9th Fighter's Squadron.

F-35 deployed to Europe for the first time



F-35A Lightning IIs, airmen and accompanying equipment arrived at Royal Air Force Lakenheath, England on 15 April, marking the aircraft's first overseas training deployment to Europe. The F-35As are from the 34th Fighter Squadron, 388th Fighter Wing and the Air Force Reserve's 466th Fighter Squadron, 419th Fighter Wing, Hill Air Force Base, Utah, and these will conduct air training over the next several weeks with other Europe-based aircraft in support of the European Reassurance Initiative.

An overseas training deployment has been part of the US Air Force's plan since the F-35A was declared combat capable last year and as part of the training deployment, the aircraft will forward deploy to NATO nations to maximise training opportunities, build partnerships with allied air forces and gain a broad familiarity of Europe's diverse operating conditions. The introduction of the premier fifth-generation fighter to the European area of responsibility brings with it state-of-the-arts sensors, interoperability, and a broad array of advanced air-to-air and air-to-surface munitions that will help maintain the fundamental sovereignty rights of all nations.

Singapore F-15SGs in New Zealand

The Republic of Singapore Air Force (RSAF) is considering basing a squadron of F-15SGs at Ohakea in Manawatu, on



New Zealand's North Island. This would provide the RSAF with additional, uncongested airspace for fighter training and would involve deployment of around 500 personnel. Once the RSAF establishes a detachment at Ohakea, this would be in addition to RSAF deployments in various countries overseas including France, the USA and at RAAF Base Pearce, Western Australia.

Boeing P-8 aircraft for US, Australia and UK



Boeing, the US Navy, the Royal Australian Air Force and the United Kingdom Royal Air Force will continue modernising global maritime patrol capabilities through a \$2.2 billion contract awarded on 30 March 2017 for at least 17 P-8A Poseidon aircraft. The agreement also includes options for 32 additional aircraft, as well as funds for long-lead parts for future orders. After exercising all options, the total contract value will be \$6.8 billion. The US Navy will receive 11 aircraft, while Australia will expand its P-8A fleet with four more. The UK's first two P-8As are part of the agreement, with first delivery set for 2019. Boeing so far has delivered 53 Poseidons to the Navy and two to the Royal Australian Air Force. The Indian Navy currently flies eight P-8I variant of the aircraft and are to receive four additional P-8Is (*see article*).

Poseidon P-8As for New Zealand



The US State Department has approved the sale of four Boeing P-8A Poseidon maritime patrol aircraft to New Zealand for some \$1.46 billion. New Zealand has a requirement to replace the Royal New Zealand Air Force's six upgraded P-3K2 Orions by mid-2025 under the *Future Air Surveillance Capability* project. Other known contenders for the P-3K2 replacement requirement include the Airbus DS C295 MPA, a maritime surveillance development of Embraer's E2 regional jet, and Japan's Kawasaki P-1.

CH-47D helicopters for Greece



Greece is procuring five CH-47D Chinook helicopters at an estimated cost of some \$80 million. These include seven Common Missile Warning Systems (CMWS), and twelve T55-GA-714A turbine engines as also mission equipment, communications and navigation equipment, ground support equipment, special tools and test equipment, spares, publications, Maintenance Work Order/Engineering Change Proposals (MWO/ECPs), technical support, and training, and other associated support equipment and services.

Boeing AH-64E Apache helicopters for US Army



Boeing have recently signed a five-year, \$3.4 billion contract through which the US Army, and another operator, will acquire the latest Apache attack helicopter, the first multi-year agreement for the Apache 'E' variant. The US Army will receive 244 remanufactured Apaches while 24 new ones will go to the "unidentified" international customer.

Additional AW139s for Pakistan



The Government of Pakistan has signed a new order for an undisclosed number of additional AgustaWestland AW139 intermediate twin engine helicopters for utility, SAR (Search and Rescue) and EMS (Emergency Medical Service) operations. Deliveries are expected to start in early 2018. A fast growing fleet of AW139s is already in service in Pakistan, with several units operated by the Pakistan Government for relief and transport duties.

Pakistan Army receives six Cessna aircraft from USA

In April 2016, the US Department of Defence had issued a \$14.9 million, fixed-price contract to Cessna Aircraft Company for two Cessna 208B Grand Caravan EX aircraft and four Cessna T-206H Stationair aircraft for the Pakistan Army, which have since received six new Cessna aircraft, two Cessna 208 Caravan and four Cessna T-206H. The contract included sustainment support and associated training. The aircraft will be configured for medical evacuation. "The Caravan and the Stationair aircraft will strengthen Pakistan Army's air mobility by enhancing its capability to conduct medical evacuations as well as provide limited troop and equipment transport."

Mi-171Es for Pakistan

The Russian Helicopters Holding Company (part of State Corporation Rostec) has made its first civil multi-role Mi-171E helicopter delivery to the government of Punjab in Pakistan. In the Punjab, the multirole Mi-171E helicopter will be used for passenger and cargo transportation, performance of air medical services, patrol work, emergency response and recovery. In January 2017, the Russian Helicopters Holding Company won an international tender and signed a contract for the Mi-171 civil helicopter delivery with the Balochistan province administration.



Malaysian MRCA Contest



Displayed at the Langkawi International Maritime and Aerospace (LIMA 2017) were Rafale and Typhoon fighters, included in the Royal Malaysian Air Force's *Tentera Udara Diraja's* Multi-Role Combat Aircraft (MRCA) acquisition programme. In October 2016, the Malaysian Defence Minister Hishammuddin Hussein said only the Rafale and Typhoon were being considered, but other

manufacturers continue their marketing including Saab with the Gripen E.

Meanwhile, the fourth and last A400M for the RMAF was handed over during LIMA 2017. The RMAF's first A400M was delivered in March 2015, followed by another in November 2015 and the third in June 2016.

Belgium announces new fighter programme

The Belgian Government has launched an acquisition programme to replace its ageing F-16s, which involves procurement of 34 multirole combat aircraft to replace the 54 F-16s presently in service. The Belgian Government plan to conclude an inter-governmental purchase agreement to replace their F-16s before the end of 2030, with a decision on the new aircraft to be made by 2018. In June 2014, an RFI was sent to five government agencies concerning the Rafale, Gripen E, F-35A, Typhoon and F/A-18E/F. The next stage in the programme will be the issuance of a Request for Government Proposal (RfGP).

RAF-PAF co-operation

Indicative of the growing links between Britain's Royal Air Force and Pakistan Air Force, was the recent visit of the RAF CAS Air Chief Marshal Sir Stephen Hillier to Pakistan in end-March 2017. He was personally briefed by the PAF CAS, Air Chief Marshal Sohail Aman, including on the PAF's ongoing counter-insurgency efforts under Operation *Zarb-e-Azb* in north-west Pakistan against Islamist elements. Both the Chiefs later flew in F-16Bs from AFS Mushaf, Sargodha. The second day had



ACM Hillier visit the PAF Academy at Risalpur, recently named after Air Marshal Asghar Khan where, as chief guest he took the salute at the passing out parade of the PAF's 118th Combat Support Course and 39th Basic Learning Pilots Course. In his speech AVM Hillier spoke of the: "RAF's valuable contribution towards development of the PAF especially in its early years, a contribution that has been deeply appreciated." He went on to add: "the relations between two countries and of course, the two air forces would continue to strengthen even further."

Later, the two Air Chiefs exchanged pennants, "twinning" their respective No 9 Squadrons, that of the PAF flying F-16A/Bs, while the RAF's IX Squadron is presently flying the Tornado GR Mk.4. The former has been participating in operations in the FATA area, while the latter is engaged over Syria and Iraq as part of the US-led coalition against the ISIS.



Air Chief Marshal Sir Stephen John Hillier, Chief of the Air Staff, Royal Air Force after flying a mission in F-16 aircraft during the twinning ceremony of No 9 Squadron at PAF Base Mushaf

Singapore Airlines in financial re-structuring



Following their massive order for 214 airliners including 67 Airbus A350s, the first of which was delivered in January 2016 and another ten delivered in the first year of operation, Southeast Asia's biggest carrier, Singapore Airlines is expected to turn to a net-debt position as early as 2018 for the first time in 13 years as the company borrows money and sells bonds to meet capital expenditure needs.

SIA, which has traditionally limited its debt load, would benefit from raising funds more cheaply through borrowings to improve return ratios and valuations, according to equity research firms. The airline, which has US\$53 billion (S\$73.95 billion) of airliners on order had expanded a medium-term note programme by two thirds to US\$5 billion in April 2017 and said it intends to "proactively" take on more debt in future. It is pertinent to point that SIA has the smallest debt-to-equity ratio among 11 major airlines on the MSCI Asia Pacific Index at 10.3 per cent, compared with 126 per cent for Cathay Pacific.

Qatar Airways adds 12 new destinations



Qatar Airways will add 12 new destinations in 2018 in addition to eight destinations for 2017 that were announced in late 2016. These cities are yet to be announced, but are characterised by "thinner markets with a leisure focus". Qatar is growing its London and Bangkok 'catchment areas' with service to Cardiff and U-tapao. Qatar Airways serves the highest number of destinations of the three Gulf airlines, about three quarters of these destinations flown by narrowbody aircraft and smaller widebodies. In a revolutionary move, Qatar Airways are also proposing services on regional routes in India's north-eastern region.

Emirates trims US flights

Emirates has reduced flights to the United States by 19 per cent with demand deteriorating after US restrictions on travel and on-board electronics affecting Middle East carriers and passengers. Thus, the world's biggest international airline will reduce capacity to Boston, Los Angeles, Seattle, Orlando and Fort Lauderdale according to the Dubai-based company. Emirates will re-deploy the capacity to serve demand on other routes across its global network.



This further stresses the need for Emirates to have smaller aircraft. Its smallest aircraft presently effectively is the 777-300ER as its handful of 777-200LRs are often earmarked for specific programmes, operationally and strategically. Smaller aircraft can open thinner markets and off peak frequencies, but can also right size existing services that are at overcapacity because the 777-300ER is too large, allowing for added frequencies. Emirates needs agility to diversify and right size its network. Emirates has been studying an order for smaller widebodies, A350s or 787s, and more recently is evaluating narrowbody aircraft, too.

Etihad Airways' A380 flights to Sydney

Etihad Airways' current daily A380 Sydney flights will be joined by a second daily mega airliner service, upgraded from a 328-seat Boeing 777-300ER. Featuring the carrier's revolutionary *The Residence*, the world's first three-room suite on a commercial airliner – the additional deployment of the 496-seat double decker aircraft to Australia's largest cities will join London and New York as an all-A380 operation.



Its Sydney – London Heathrow route, via Abu Dhabi, will also offer guests the consistency, convenience and comfort of a seamless all-A380 service in both directions. Etihad Airways' three daily London Heathrow flights are operated with an A380. Beginning 1 June, the second daily New York service will be upgraded to the 'superjumbo.' Introduced on the Sydney route two years ago, the A380 accommodates up to two guests in *The Residence*, which features a living room, bedroom and shower, together with nine First Apartments, 70 Business Studios and 415 Economy Smart Seats.

Myanmar Airlines' flights to Bodh Gaya



Though Myanmar Airways International has been operating a flight on Yangon-Gaya route in the tourist season (October-March) for the last several years, the airline would be now also be operating off-season flights. From May onwards, till commencement of the 'tourist season', the airline would operate a weekly flight every Monday, even as Air India operates a weekly flight on the Delhi-Gaya-Yangon route.

Meanwhile, Srilankan Airlines are to operate Gaya-Colombo flights from July 2017 as unlike pilgrims and tourists from Europe and several South East Asian countries, Sri Lankans visit Bodh Gaya in large numbers in the rainy season (July-August) and for that reason Srilankan Airlines has scheduled its flights to synchronise it with demand.

Airbus A319neo launched

The first Airbus A319neo performed its maiden flight on 31 March, being the smallest member of the A320neo Family, powered by CFM International LEAP-1A engines. The A319neo offers its operators superior short field performance in hot and high conditions and can accommodate up to 160 passengers "without compromise on the comfort."

The A320neo Family is the "world's best-selling single aisle" product line with over 5,000 orders received from over 90 customers, amounting to almost 60 percent share of the market. The A320neo Family incorporates latest technologies including new



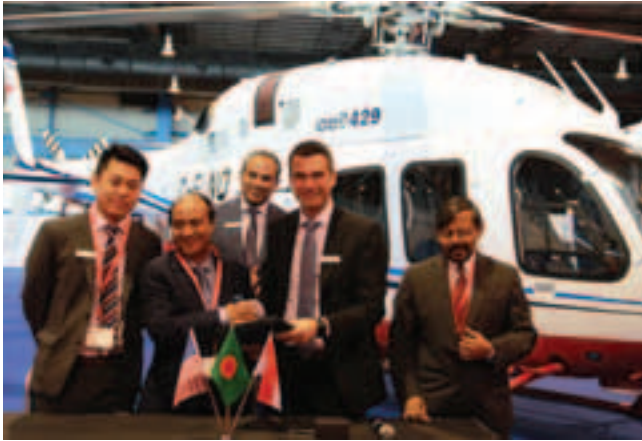
generation engines and Sharklet wing tip devices, which together deliver "more than 15 percent in fuel savings from day one and 20 percent by 2020."

AW119Kx demo tour in Nepal



Leonardo has embarked on a demo tour with its AW119Kx single engine helicopter together with Simone Moro, the only alpinist in history to have reached four 8,000 metre peaks in winter. Initial flying activities took place between 24-28 March with conclusion in mid-April. The demo tour aims to test some features of the AW119Kx at high altitudes, simulate passenger transport missions starting from Nepal's capital, Kathmandu, to several base camps in the surroundings, but at higher altitudes, enable some potential clients to participate in such missions and test the helicopter capability, carry out high-altitude aerial work activities, including several tests for the transport of materials with the cargo hook.

Bell 429 for Meghna in Bangladesh



Bangladesh's Meghna Aviation Ltd have become that country's first operator to procure the Bell 429 helicopter. "Meghna Aviation has chosen the Bell 429 to meet its growing needs for reliable air transportation for its operating bases in Bangladesh," stated a company official, adding that "the Bell 429 is a perfect complement to the Bell 407GX that Meghna Aviation currently operates."

Japan Air Commuter starts operations with ATR 42-600



Japan Air Commuter Co. Ltd. (JAC) flew its first ATR 42-600 flight from Kagoshima to Yakushima and then performed three flights, from Yakushima to Kagoshima, from Kagoshima to Okinoerabu, and back to Kagoshima. A subsidiary of Japan Airlines, the national flag carrier, JAC is a new ATR operator, the entry into service being seen as a major milestone for ATR, for which Japan is a key market. The new ATRs will be operating on connections from and to small islands and communities across the country.

Rolls-Royce Trent 700 engines for Lion Group's A330s



The Lion Group will procure Rolls-Royce Trent 700 engines to power three new Airbus A330 aircraft, supported by Rolls-Royce's flagship engine service, *TotalCare*. The Lion Group already operates three of the aircraft, all powered by the Trent 700 engine. Edward Sirait, CEO, Lion Group, said: "These aircraft are an exciting addition to our widebody fleet, allowing us to deliver new routes for our customers. We have already seen the economic advantages of the Trent 700 and *TotalCare* service with our in-service aircraft and we are very pleased to continue with this combination for our new aircraft."

Airbus A350-1000 completes test campaign in Spain

Airbus' A350-1000, MSN065 test aircraft, fitted with full cabin, completed a series of noise tests in Moron, south of Spain, between 27 March and 5 April, as part of its type certification flight test campaign, paving the way for entry into service on schedule before this year end. The aircraft, together with acoustic ground facilities around the Morón Air Force base, were equipped with



instruments and sensors to measure external noise levels during the take-off and landing phases of flight, as well as engine run ups. The latest generation Rolls-Royce engines combined with state-of-the-art aerodynamics technologies contribute to the A350-1000's reduced noise footprint. Early results confirm the -1000 "is very quiet", easily complying with external noise certification requirements with significant margins versus current applicable requirements (EASA CS-36 and FAA Part 36).

Airbus A350 XWBs for China Southern Airlines



China Southern Airlines has signed a purchase agreement with Airbus for 20 A350-900s, this carrier arguably having one of the largest Airbus fleets in the world with more than 300 Airbus aircraft in service, comprising the A320 Family, the A330 Family and five A380s. As Tan Wangeng, President of China Southern Airlines stated, "With its very long range capability, economic fuel consumption and spacious cabin, the A350 XWB is the ideal choice for our international long haul routes. The introduction of the A350 XWB will help to strengthen our position as one of the world's leading international carriers."

A321neo for Virgin America

Airbus has delivered an A321neo powered by CFM International's LEAP-1A engines to US airline Virgin America, an all-Airbus operator, at a ceremony at Hamburg in Germany. Equipped



with fuel-saving Sharklet wingtip devices, nitrous oxide emissions are 50 percent below regulatory requirements as outlined by the Committee on Aviation Environmental Protection (CAEP). In addition, the aircraft will result in 15 percent fuel savings compared to Virgin America's current generation aircraft, which is equivalent to cutting 5,000 tons of carbon dioxide emissions with each aircraft every year.

Dassault Rafale F4 launched



On 20 March 2017, the French Minister for Defence, Jean-Yves Le Drian, authorised development of the new Rafale F4 standard. As early as 2023, a first version of the F4 standard will follow the F3-R standard, scheduled for qualification in 2018. "I am delighted by the Minister for Defence's decision. The F4 standard will incorporate operational experience feedback and enable continuous improvement of the Rafale to be maintained. It will reinforce the national skills and technological capabilities essential for preparing the development of the next generation of combat aircraft", stated Eric Trappier, Chairman and CEO of Dassault Aviation. "I am also delighted that the Defence Ministry underlines the need to continue with acquisition of the Rafale, beyond the 4th tranche currently in production, in order primarily to meet the needs of the French Air Force. Finally, this robust national foundation will constitute a launch pad for our aircraft in future export markets."

Maiden flight of twin-seat JF-17

The first twin-seat JF-17B fighter-trainer made its maiden flight at Chengdu on 27 April 2017, being unmarked except for the tail, which had a combined Chinese-Pakistani fin-flash. Yang Wei chief designer of the JF-17 said that the twin-seat variant "brings a new dimension to the JF-17 family and will increase the type's competitiveness in the global market." An AVIC spokesman said that the JF-17B has been developed with a global market in mind, development of the two-seater fighter being supported by firm orders for the type.

On its maiden flight, the JF-17 flew for some 26 minutes and will continue to be flight tested till certification and commencement



of series production. There will be three JF-17B prototypes, two of which are earmarked for the Pakistan Air Force, while the third will be retained at Chengdu for further development tests.

50th anniversary of the Gazelle



On 25 April 2017, Airbus Helicopters celebrated 50th anniversary of the Gazelle's maiden flight at the Museum of Aviation in St Victoret. Fifty years after its maiden flight on 7 April 1967, the Gazelle is still being operated by nearly 100 customers in 34 countries and it is known for its ease of maintenance and high reliability. Developed and manufactured in cooperation with the United Kingdom at the end of the 1960s, more than 1,250 Gazelles have been delivered. Today 470 such rotorcraft, more than a third of all Gazelles manufactured, are still in service, a hundred of which are operated by the French army.

Britain's RWUAS

The British Ministry of Defence is to begin Phase 2 of the Rotary Wing Unmanned Air System, Capability Concept Demonstrator (RWUAS CCD) programme, which aims to develop technologies and procedure for future unmanned rotary wing and

vertical takeoff and landing (VTOL) aircraft. Phase 2 will complete research and development (R&D) activity, which began under the RWUAS CCD Phase 1 between 2013 and 2015 and draws upon the results of the Unmanned Warrior demonstrations.

The RWUAS CCD Phase 2 comprises a two year, £8m investment in R&D. The MOD will partner with Leonardo Helicopters to use the SW-4 Rotary Wing Unmanned Air Vehicle (RUAV) Solo demonstrator. According to Leonardo, RWUAS CCD Phase 2 aims to "identify, develop and exploit the opportunities offered by emerging technologies, to reduce costs and increase the agility, flexibility, resilience and persistence of national military equipment and capability in the rotary-wing arena."

Light Joint Helicopters for France



The French MoD are to order 160-190 Airbus H160 helicopters to meet the inter-service Light Joint Helicopter requirement, with the new helicopters to start service entry in 2024. The Light Joint Helicopter (LJH) will replace a variety of types including Gazelles, Fennecs and Alouette IIIs in a common fleet that will streamline operations and support. This new-generation twin-engine H160 will first be introduced on the civilian market in 2018 (see picture), but the French military involvement is seen as a vital launch pad for the type as a light transport, liaison, search and rescue and training platform.

Germany to order Tritons

The Bundeswehr is to procure the MQ-4C Triton from Northrop Grumman to replace the planned EuroHawk which programme was cancelled in May 2013. The Tritons will be delivered in 2025 and will be procured directly from the US Navy. The aborted EuroHawk programme for five unmanned aerial vehicles was cancelled owing to complications when certifying the aircraft to fly in civilian airspace. In another programme, the Luftwaffe are to procure six C-130Js from Lockheed Martin to supplant its ageing C-160 Transalls.

The B-21 Advanced Strategic Bomber



Developments on the Northrop Grumman B-21 Raider advanced strategic bomber have progressed after a review initiated to provide additional “insight and fidelity into the programme design since technology development”. Vice Chief of the USAF Gen Stephen Wilson observed that the review was conducted earlier this year. Air Force Global Strike Command (AFGSC) Chief Gen Robin Rand has said that 100 B-21s are the stated requirement, which figure had been decided in spring 2016.

Northrop Grumman had won the B-21 contest in October 2015, beating the rival Boeing-Lockheed Martin offer. The current estimate is that the B-21 will cost around \$550m per aircraft and will enter operational service from the mid-2020s.

USAF plans ‘Sixth-Gen fighter’

In characteristic manner, the USAF are planning a sixth-generation fighter with the nomenclature *Penetrating Counter-Air* (PCA). A supplemental budget requests increase in the Fiscal Year 2017 plan by \$30bn for immediate PCA funding from \$21m to \$168m for research, development, test and evaluation (RDT&E). The PCA is designed to supplement and eventually replace the F-22 Raptors in USAF service from after 2030.

Saab Gripen’s development support



Sweden’s Saab has received an order valued at SEK 375 million from the Swedish Defence Materiel Administration (FMV) to provide operational and development support for the Gripen during 2017. The order includes the operation of rigs, simulators and test aircraft for the verification and validation of the Gripen C/D and Gripen E fighter aircraft systems, plus operational support for Gripen C/D.

Meanwhile, Saab has signed a contract worth SEK3.2 billion with the Swedish Defence Materiel Administration (FMV) for development and production of the next generation anti-ship missile system, with deliveries to take place during 2017-2026. The next generation anti-ship missile system will be integrated on the new Gripen E fighters and in the *Visby*-class corvettes.

Saab’s airborne SPS for Luftwaffe



Saab has received an order for BOZ-101 EC electronic warfare self-protection and countermeasures systems from the NATO Eurofighter 2000 and Tornado Management Agency (NETMA) for the German Air Force. The BOZ self-protection and countermeasures system has been in use on the Tornado for many years, and the current order is for 29 units of the enhanced version. The wing-mounted pod consists of a missile approach warning system in the aft section and a countermeasures dispensing system. Dispensing can be performed forward, downwards, and sideways in two adjustable directions, designed to counter modern IR-guided threats. The production of the BOZ-101 EC will take place at Saab sites in Järfälla, Sweden and in Centurion, South Africa, with deliveries to take place during 2017-2020.

Rockwell Collins for Pakistan Air Force C-130 upgrades

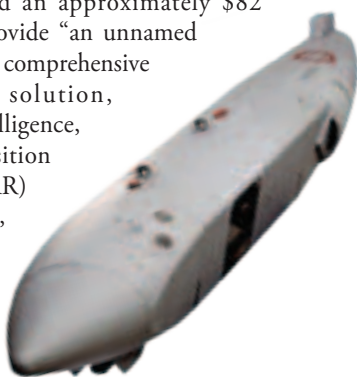
The Pakistan Air Force has selected Rockwell Collins’ Flight2 avionics systems for the upgrade of some 11 C-130E and 5 C-130B aircraft to provide the integrated avionics suite along with



training and technical support during installation. Additional support includes consolidated flight manuals, checklists and maintenance supplements required to operate and maintain the fleet. Included in the avionics upgrade is a full glass cockpit with new primary flight displays and precision airdrop software. "The upgrade will provide the Pakistan Air Force with state-of-the-art capabilities consistent with the world's leading C-130 operators." Work will be performed in Pakistan and is expected to be completed by 31 December 2020.

Elbit Systems' Condor 2 Strategic ISTAR ordered

Elbit has been awarded an approximately \$82 million contract to provide "an unnamed Asia-Pacific country" with a comprehensive Electro-optic airborne solution, Condor 2, for use in intelligence, surveillance, target acquisition and reconnaissance (ISTAR) missions. The contract, which is a follow-on order from the same customer, will be performed over a four-year period by Elbit Systems' ISTAR Division, being performed in cooperation with ELTA Systems Ltd., who is supplying additional content to the same customer.



Elbit Radio Systems for Israeli MoD

Elbit has been contracted by the Israeli Ministry of Defence for the supply of advanced radio systems and will provide "hundreds" of radio systems over the course of five years. In



addition, Elbit Systems is expected to receive additional order to provide repair and maintenance services for 15 years. Elbit Systems will also provide the IDF with hand held, vehicle mounted and airborne third generation Software Defined Radios (SDRs), enabling advanced network services at a high security level. The maintenance activity will be performed under an outsourcing model, as part of the Israeli Defence Ministry's strategy to establish a full array of radio systems at high operational availability while significantly reducing maintenance expenses.

IAI's Targeting and Surveillance Pods for "Asian customer"

Israel Aerospace Industries have signed a \$200 million contract with an "unidentified customer" in Asia to provide targeting and surveillance pods to its air force. The contract will be carried out by ELTA Systems Ltd., a Group and Subsidiary of IAI (IAI/ELTA) and is a follow-up order for the new generation of targeting and surveillance pods already used extensively and successfully by the country's air force.

Launch of MBDA's ASRAAM from F-35



The F-35 Lightning II stealth fighter jet has conducted its first firing trials of the MBDA Advanced Short Range Air-to-Air Missile (ASRAAM), the first time a British-designed missile has been fired from the F-35 Joint Strike Fighter, and the first time any non-US missile has been fired from this aircraft. MBDA is currently under contract to produce the highly capable infra-red (IR) guided air-to-air missile for the UK's F-35s.

Meteor integration on F-35s for RAF

The British MoD has contracted MBDA for the integration of the Meteor Beyond Visual Range Air-to-Air Missile (BVRAAM) on the RAF's new F-35 Lightning II, including test assets, productionisation and engineering work needed to support Meteor's compatibility with the F-35. The contract follows-on from the successful firing trials of MBDA's Advanced Short Range Air-to-



Air Missile (ASRAAM) from the F-35 earlier this year. ASRAAM is being integrated onto the F-35 as part of the aircraft's Block 3 SDD programme. To follow shortly will be integration with the F-35 of MBDA's SPEAR precision surface attack missile. Meteor and SPEAR are advanced weapons that complement the '5th gen' F-35, bringing networked capability with stand-off and both weapons are key elements of the UK's carrier strike capability in the future.

MBDA's CAMM for UK

MBDA has secured a £323 million deal for the next batch of futuristic air defence missiles for the British Army and Royal Navy, the next-generation Common Anti-air Modular Missile (CAMM) being compatible for operation both at sea and on land, with the capability to counter anti-ship cruise missiles, aircraft and other highly sophisticated threats. Designed and manufactured by MBDA in the UK, CAMM will be deployed using the Sea Ceptor and Land Ceptor weapon systems that will protect the Royal Navy's Type 23 and future Type 26 warships, as well as enhancing the British Army's Ground Based Air Defence system.



Standard Missile-6 passes tests

After a complex series of US Navy flight tests, Standard Missile-6 has attained full operational capability, signifying the weapon's sea worthiness with no more testing required. SM-6, produced by Raytheon Company is the only missile in the world that can perform anti-air warfare, anti-surface warfare, and terminal ballistic missile defence. Four SM-6 missiles were fired throughout the testing, each against a single shore-launched, sub- or supersonic target. Final assembly of SM-6 would be at Raytheon's production facility at Redstone Arsenal in Huntsville, Ala. Raytheon has delivered more than 330 SM-6 missiles with continuing production. The US Department of Defence has approved the release of SM-6 to several international customers in early 2017.



More aircraft carriers for the USN

During his visit to the Newport News shipyard, Virginia, in early March as part of a pre-commissioning ceremony for the USS *Gerald R Ford* aircraft carrier, President Donald Trump has announced plans to augment the US Navy into having a 12-carrier fleet. He said that, "In these troubled times, our Navy is the smallest it's been since World War One, and have plans to undertake a major expansion of our entire navy fleet, including having the 12-carrier Navy we need." He stressed that aircraft carriers are the "centrepiece" of US military capability.

HMS *Queen Elizabeth* to embark Merlins



The Royal Navy will embark Merlin HM2 helicopters from 820 Naval Air Squadron on the new aircraft carrier HMS *Queen Elizabeth*, being scheduled for late 2017. Based at Royal Naval Air Station on Culdrose, Cornwall, the 802 NAS Merlin HM2s, will be the first aircraft to land on board HMS *Queen Elizabeth* as she sails from Rosyth to make her debut at her home port of Portsmouth.

Bataan ARG deployed



The *Bataan* Amphibious Ready Group (ARG) has recently begun deployment to Europe and the Middle East. Together with the 24th Marine Expeditionary Unit (24th MEU), the *Bataan* ARG departed from Naval Station Norfolk and Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach, Virginia and Camp Lejeune, North Carolina, in March 2017. The *Bataan* ARG comprises the amphibious assault ship USS *Bataan* (LHD 5), amphibious transport dock USS *Mesa Verde* (LPD 19), Tactical Air Control Squadron 21 and Helicopter Sea Combat Squadron (HSC) 26, with homeport at Naval Station Norfolk, amphibious dock landing ship USS *Carter Hall* (LSD 50), Assault Craft Unit 4 detachments, and Beach Master Unit 2, with homeport at Virginia Beach. The aviation component of the 24th MEU is Marine Medium Tiltrotor Squadron 365 (Reinforced).

MBDA supports Royal Navy Type 45 destroyers' Sea Viper weapon system



MBDA has received a £175 million contract from the British MoD for further In-Service Support to the Sea Viper weapon system, securing a key capability of the Type 45 fleet. Called 'Sea Viper Unified Support Environment Period 1', the contract will cover the continuing in-service support to the Sea Viper weapon system, including the Aster missile that protects the Royal Navy's Type 45 destroyers, for the next five years.

MBDA's Sea Venom/ANL missile compatibility Super Lynx helicopters



MBDA has conducted air carriage and jettison trials of its new generation Sea Venom/ANL anti-ship missile on board the Lynx Mk 8 naval helicopter, thus validating that the missile can be integrated onto the Lynx and Super Lynx helicopters, which remain in frontline service with many customers worldwide. Sea Venom/ANL has been developed to deliver an enhanced capability to replace existing and legacy systems such as the UK-developed Sea Skua and the French-developed AS15TT anti-ship missiles.

The first Gowind 2500 by DCNS in sea trials



DCNS has conducted initial sea trials of the first of *Gowind*-class 2500 corvettes under construction in Lorient, France by DCNS. Ten *Gowind* 2500 corvettes, which will supplement DCNS surface vessels, have been ordered so far by various international navies including Egypt and Malaysia.

DCNS' multi-mission frigate *Auvergne* for the French Navy

DCNS delivered the FREMM multi-mission frigate *Auvergne* to the French Navy on 11 April in Toulon, this being the fourth of the series ordered by OCCAR on behalf of the DGA (French armament procurement agency). On completion, the FREMM programme comprises the construction of ten vessels at the DCNS Lorient site, of which eight are for the French Navy. Six FREMM would have been delivered to the French Navy before end of 2019, in accordance with the 2014-2019 military programming law.



DCNS is currently completing the FREMM *Bretagne*, which was floated on 16 September 2016, and is completing assembly of the FREMM *Normandie*. Furthermore, work has already started on the ninth FREMM in the series, the *Alsace*, which will be one of the two FREMMs with strengthened anti-aircraft capacities, whose deliveries are scheduled before 2022.

Thales' French intermediate-size frigate programme

Thales and DCNS have been contracted by the French defence ministry for the development and construction of five intermediate-size frigates for the French Navy under the FTI (*Frégate de Taille Intermédiaire*) programme managed by the French defence procurement agency (DGA). The first frigate will be delivered in 2023 and is scheduled to enter service in 2025. The SEA FIRE radar is developed and integrated in Rouen and Limours, while the CAPTAS-4 compact sonar is manufactured in Brest and Sophia-Antipolis. Systems engineering for the Aquilon system is carried out in Gennevilliers, and the SENTINEL electronic warfare system is produced at the Cholet and Brest facilities. Laval and Brive-La-Gaillarde are involved in developing the IFF and naval V/UHF radio, respectively.



BAE launches HMS Audacious

HMS *Audacious*, the fourth of seven *Astute*-class attack submarines being built for the Royal Navy, was launched by BAE Systems at its site in Barrow-in-Furness, Cumbria, UK on 28 April 2017. The 97-metre long, 7,400 tonne highly-capable nuclear powered submarine which was officially named at a ceremony in December last year, emerged from the site's giant Devonshire Dock Hall and was lowered into the dock water for the first time to begin the next phase of its test and commissioning programme ahead of leaving Barrow for sea trials next year.



Armed with Spearfish torpedoes and Tomahawk land attack missiles, the *Astute*-class submarines are "the most highly-capable submarines ever built for the Royal Navy", which can strike at targets up to 1,000km from the shoreline with pin-point accuracy, are equipped with a world-leading sonar capability and powered by a nuclear reactor. The first three submarines in the class, HMS *Astute*, HMS *Ambush* and HMS *Artful*, are now in service with the final three *Astute*-class submarines at various stages of construction at the Barrow site.

Elbit's HDTs for US Navy

Elbit Systems of America has been awarded an Indefinite Delivery/Indefinite Quantity (ID/IQ) contract for approximately \$50 million by the US Navy to provide



the Helmet Display and Tracker System (HDTs) with the Continuously Computed Impact Point (CCIP) algorithm, for the MH-60S. The work will be performed in Fort Worth Texas, and completed by June 2021 and is the US Navy's first production order for the line-of-sight helmet tracking system and the integration of targeting symbology in the Armed Helicopter Weapon System (AHWS) for the MH-60S fleet.

Raytheon's AMDR executes Test

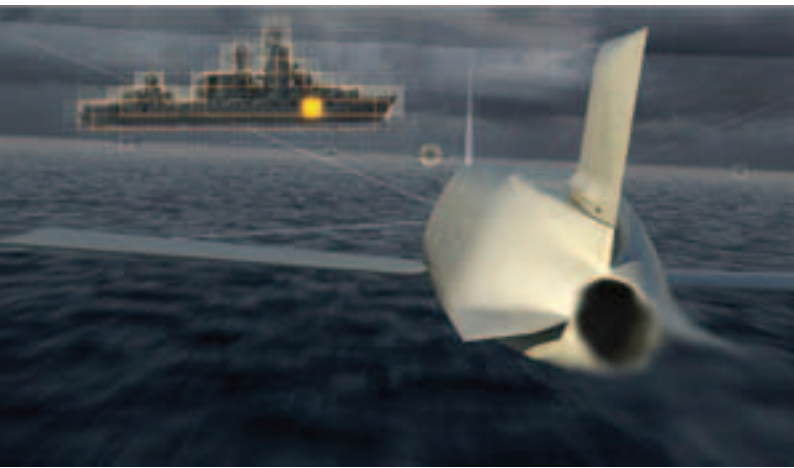
Raytheon Company's Air and Missile Defence Radar acquired and tracked a ballistic missile test target during the radar's first dedicated Ballistic Missile Defence exercise at the US Navy's Pacific Missile Range Facility (PMRF), Kauai, Hawaii. This follows a series of successes for AN/SPY-6, including the tracking of integrated air and missile defence targets of opportunity, satellites and aircraft.



Since installation at the PMRF in May 2016, AMDR has tracked targets of increasing complexity, demonstrating that the radar is meeting its performance requirements. In October 2016, AN/SPY-6 first tracked these multiple satellites, hundreds of miles above the earth, from search and acquisition through their orbits. In the following month, the radar executed its first integrated air and missile defence track by simultaneously tracking aircraft and satellites. Most recently, in conjunction with a Standard Missile 3 Block IIA SFTM-01 flight test, AN/SPY-6 executed an engineering exercise where it searched for, acquired and tracked a medium range ballistic missile target, from launch through flight.

LM LRASM flight test from US Navy F/A-18E/F

In a recent test, Lockheed Martin's Long Range Anti-Ship Missile (LRASM) was launched from a US Navy F/A-18E/F Super Hornet at NAS Patuxent River, Maryland, to validate the aerodynamic separation models of the missile and paving the way for integration testing scheduled for mid-year at the Navy Air



Weapons Station (NAWS) China Lake, California. LRASM is designed to detect and destroy specific targets within groups of ships by employing advanced technologies that reduce dependence on intelligence, surveillance and reconnaissance platforms, network links and GPS navigation.

Raytheon's new electric gun for Phalanx Close-In Weapon System

Raytheon have tested a new electric gun for the Phalanx Close-In Weapon System, the upgrade enabling operators to fire at varying rates. Phalanx is a rapid-fire, computer-controlled radar and

20 mm gun system that automatically acquires, tracks and destroys enemy threats that have penetrated all other ship defense systems. The goal of the live-fire test was to ensure the electric gun can operate despite the heavy vibrations that occur when Phalanx is fired. The new design replaces a pneumatic motor, compressor and storage tanks, reducing the system's weight by 180 pounds. More than 890 systems have been built and deployed in navies around the world.



China's C919 in maiden flight

The C919, China's first domestically designed and built regional airliner, made its maiden flight on 5 May and landed one hour and 20 minutes later. With the flight, China

joins the ranks of the few nations that have developed homegrown large airliners: the US, Russia, Brazil, Canada, UK, France and Germany. Developed and manufactured by the Commercial Aircraft Corporation of China (COMAC), the 168-seat C919 is approximately the same size as Airbus's A320 and Boeing's 737-800. While the Chinese will endeavor to market the type to international operators, the C919's main customers will logically be China's domestic airlines.





Rafael's LITENING-5 & RECCELITE pods

Litening 5 on Gripen

Rafael Advanced Defense Systems have presented Litening-5, a combat-proven multi-spectral airborne targeting and navigation pod. Designed for navigation and target illumination, Litening significantly enhances day and night attack capabilities being one the world's leading, and most widely-used electro-optic targeting and navigation pod. Used on combat aircraft, Litening provides easy to operate, reliable, day and night precision strike capability, in adverse weather conditions.

Mounted externally to the aircraft, Litening contains advanced forward looking infrared (FLIR) and Charge Coupled Device (CCD) sensors. High-resolution images of the target are presented to the aircrew, with wide field of view search capability and precision acquisition and targeting. 'Unmatched' sensor resolution enables aircrew to reliably detect

and identify targets by day and night, in all weather conditions. Over 1,400 Litening pods have been procured by 26 countries and Litening pods have logged more than two million flight hours in total.

The RecceLite is a self-contained self-cooled multi-sensor tactical reconnaissance system, consisting of an airborne pod based on the Litening Targeting and Navigation Pod and a ground exploitation station. The RecceLite simultaneously collects Infra-Red (IR)

and Visual (VIS and near IR) digital images within a very wide field of regard, in accordance with an automatic mission plan and/or manual operation. The RecceLite pod is a derivative of Rafael's Litening navigation and targeting pod, which is in use in air forces worldwide. Together, the RecceLite and Litening provide a highly effective solution for shortening the critical sensor-to-shooter cycle.

The Recce-U is a real time ISR system for UAVs. Based on the RecceLite system,

Recce-U transforms the way persistent ISR and IED detection missions are carried out. Recce-U simultaneously collects high resolution infrared (IR) and visual digital images in an unlimited field of regard. These variety of scanning modes provide optimal photography of all terrains and combine accurate area coverage with high quality imagery.



The Recce-U

SeaHake: The German Torpedo



At the Euronaval show in October 2016, senior Atlas Elektronik executive Wolfgang Klose informed this *Vayu* correspondent that the DM2A4 *Seehecht* (export name: SeaHake mod4), the main underwater weapon of the German Navy's Type 212 submarines, has been proposed as a 'Make in India' initiative. The heavyweight torpedo, weighing 1.37 tonnes, can be launched from both submarines and surface ships. The weapon is 6.6 m long when configured with 4 battery modules, and is respectively shorter when configured with either 3 or 2 battery modules, while diameter remains constant at the standard 533 mm.

Developed by Atlas Elektronik, the SeaHake mod4 torpedo employs fibre optic wire guidance in conjunction with advanced signals processing and mission logic to accurately engage underwater and above-water targets, and carries a 255 kg PBX warhead with magnetic influence and contact fuses. The torpedo is equipped with a high frequency permanent magnet motor (with a closed-loop cooling system independent from the environment) and silver zinc battery modules ensuring a maximum speed of 50 knots and a range of over 50 km.

With a fully digital system architecture, increased range and speed and its new conformal array sonar with a very wide panoramic sensor angle as well as the additional wake-homing sensor, the DM2A4/SeaHake mod 4 provides greatly advanced performance over its predecessor. The homing head shell is of hydrodynamic optimised parabolic shape, which aims to reduce torpedo self-noise and cavitation to an absolute minimum. The homing head's

conformal transducer array permits detection angles of ± 100 degrees in the horizontal and ± 24 degrees in the vertical, therefore supporting larger acquisition angles in comparison to traditional flat arrays. The wide angle array is designed to reduce manoeuvring when in search and reconnaissance stages, therefore also reducing self-noise and preserving battery power.

Meanwhile, Atlas Elektronik have developed the SeaHake mod4 ER version that along with Global Positioning System (GPS) guidance and Satellite Communication (SATCOM) with signals received through a mini periscope, enables the torpedo to attain a range of 140 km.

Sayan Majumdar



“National Treasure of Russia”

Irkut at LIMA

Russian Knights perform with Su-30MKM fighters

Irkut Corporation (a UAC member company) took part in LIMA'17 (the Langkawi International Maritime and Aerospace exhibition), Malaysia, from 21 to 25 March 2017.

Irkut-manufactured Su-30SM and Su-30MKM fighters of the Russian and Royal Malaysian Air Forces respectively flew over the exhibition, with the Su-30SM making its debut in colours of the Russian Knights

aerobatics team. In addition, Irkut's entire product line was on display in model form at the UAC stand: the Su-30SME fighter, the Yak-130 and Yak-152 training aircraft, and the new MC-21 commercial airliner.

On first day of the show, top officials from Irkut Corporation and UAC held a meeting with pilots from the Russian Knights aerobatics team and the RMAF's 11th Squadron. Crews of both countries praised the flight characteristics of their Su-30-family aircraft. General Dato' Sri Hj Affendi bin Buang, Chief of the Royal Malaysian Air Force, said the Su-30MKM fighter was “among the best of its class and expressed his gratitude to the builders of the aircraft. Development of the Su-30MKM programme is very important for Malaysia's defence capability,” he said.

The Malaysian and Russian pilots, whose performances evoked the admiration of the audience, praised the flight characteristics of their aircraft. Col Gborg, a Royal Malaysian Air Force pilot said the Su-30MKM was a “wonderful aircraft. This is the best fighter I have flown in my twenty-year career,” he stressed!



Pilots of the Russian Knights and the RMAF's 11th Squadron pose with Su-30SMs on the first day of LIMA'17



Su-30SMs taking off

Irkut President Oleg Demchenko remarked on the skills of the pilots and their ability to use the the fighter's capabilities to their fullest.

UAC's Alexander Tulyakov said: "Positive assessment of aircraft given by Russian and Malaysian pilots is very important for us - both developers and manufacturers."

At the Russian Knights press conference, Commander of the Russian Air Force - Deputy Commander-in-Chief of the Aerospace Forces of Russia Lt Gen Andrey Yudin stated that the Russian

Knights' new Su-30SM fighters featured essentially all new piloting and combat capabilities. Col Andrey Alekseev, who leads the Russian aerobatic team, said: "It is a great honour for us to represent the Russian Air Force with Su-30SM fighters, here in Malaysia. Pilots of our aerobatic team have mastered the Su-30SM, and we will start to demonstrate aerobatics with six aircraft soon."

The daily demonstrations by the Russian Knights were certainly crowd pleasers while Irkut President Oleg Demchenko, called the team a "national treasure of Russia."



Su-30MKM



Four Su-30SMs in formation



Russian Knights during their display



Su-30SM streams brake parachute on landing



The Russian Knights in action



Second Yasen-class Submarine 'Kazan' launched

The improved *Yasen*-class (Project 855M) multipurpose nuclear-powered submarine *Kazan* was launched at the Sevmash shipyard in Severodvinsk on 31 March 2017, with Russian Deputy Prime Minister Dmitry Rogozin and Russian Navy Chief Admiral Vladimir Korolyov in attendance at the ceremony. *Kazan* is the second Project 855 (*Yasen*) boat, but has been extensively modified and updated compared to the lead ship of the class, *Severodvinsk*, which was designed in the 1980s, laid down in 1993, and commissioned only in 2013.

"The launch of an improved *Yasen-M* advanced multi-role submarine is quite an event for the whole of the country, its armed forces and its Navy. We are working together on a plan approved by the government. We are in the process of creating a submarine group capable of coping with missions around the world and maintaining Russia's security," said Admiral Korolyov at the event.

Kazan has been under construction at Sevmash since 2009, and is to be handed over to the Russian Northern Fleet in 2018. A total of seven *Yasen*-class submarines are to be built by 2023. The class is designed by the Malachite Design

Bureau based in Saint Petersburg, with four more 885M boats – *Novosibirsk*, *Krasnoyarsk*, *Arkhangelsk* and *Perm* – currently under

various stages of construction. The seventh submarine of the class will be laid down in the summer of 2017.



Malachite Design Bureau CEO Vladimir Dorofeev watches as *Kazan* heads out to be launched (all photos: Oleg Kuleshov)

The Saab RBS 70NG : Terminal Challenge

The Saab RBS 70NG VSHORAD (Very Short Range Air Defence) System, comprising surveillance radar and firing units, is on offer to the Indian Army to fill a crucial gap in their Ground Based Air Defence (GBAD). The RBS 70 NG system's automatic tracking capabilities and ability to detect multiple targets, both day and night, meets and exceeds the requirements of the Indian Armed Forces for a VSHORAD system. The RBS 70 in its various evolving versions is operational with the Swedish armed forces and has also been exported to 18 countries worldwide.

The RBS 70 missile can be operated independently in stand-alone mode or can be configured with several firing units (up to nine) linked with truck-mounted Saab Microwave Systems Giraffe surveillance radar to form an anti-aircraft battery protecting an area of 175 square kilometres. The target data, including range, bearing and velocity is transmitted to each designated missile firing post. The RBS 70 system entered service in 1978 with the 2 km ranged Mk.1 missile providing altitude coverage of more than 5 km. Current production model is the fourth-generation all-target Bolide (in RBS 70 NG) missile (a further development of the Mk 2) with increased speed and manoeuvrability ensured by the new sustainer rocket motor. The system, entering the digital era, also included non-cooled laser diodes (No Freon), BORC Thermal Imager, Digital Identification Friend & Foe (IFF) Interrogator, Target Data Receiver, PC-based Weapon Simulator and external power supply.

The RBS 70 NG comprises the 'beam rider' Bolide missile in the launch container, a tripod firing stand and an optical sight, operable by one, and portable by three persons. The system can be vehicle-mounted by rapid moving units and remotely controlled. The missile is equipped with a solid propellant booster motor developed by Bofors and a solid propellant sustainer motor by BAE Systems Land Systems (Royal Ordnance) and Imperial Metal Industries. When the operator fires the missile, the booster motor is ignited inside the launch tube and the missile is accelerated out of the tube. The control surfaces and the



four fins open into position as the missile leaves the tube. The sustainer motor ignites after the missile has travelled a safe distance from the launch position, subsequently jettisoning the booster.

Presently, FLIR Systems close loop cooled Clip-On Night Device (COND) operating in the 8-micron to 12-micron infrared band (with a 12x 8-degrees field of view) ensures day and night capability to be replaced by BORC, based on Quantum Well Infrared Photodetector (QWIP) thermal imaging technology. A hostile target can be located visually by the missile operator or detected by the Giraffe surveillance radar. When the target is acquired, the operator tracks the target in tandem Raytheon Cossor IFF880 Identification Friend or Foe (IFF) system. If a friendly target is detected, a warning light in the sight is illuminated halting the firing sequence. However in case of a hostile intrusion the operator (this *Vayu* observer was fortunate to operate in simulation multiple times) aims the missile towards the target, fires and tracks the target, aiming a laser guidance beam continuously at the target until the moment of impact. The RBS 70 NG sight enhances the capability of the BOLIDE missile by reducing the tracking noise through the implementation of an auto-tracker function. Lowered noise will result in even higher maneuverability and higher kill-probability than in the present RBS 70 system against small targets at maximum range.

Since the missile has no seeker head at front of the missile and the laser beam riding system resides in the tail, the missile is highly jam resistant, being unaffected by hostile countermeasures, heat sources and clutter. The 1.1 kg fragmented shaped charge warhead is fitted with a Saab Bofors adaptable laser proximity fuse plus an impact fuse to ensure destruction of fixed and rotary wing aircraft to small and dark targets such as cruise missiles and Unmanned Aerial Vehicles (UAV) plus armoured targets, including attack helicopters and armoured personnel carriers (APC). The system is uniquely capable of operating in a complex environment such as urban terrain and can be used in tropical, desert and arctic conditions.

With short reaction and engagement time, the RBS 70 NG has a maximum speed of more than Mach 2, an effective intercept range of between 250 metres to 8 km, with altitude coverage in excess of 5,000 metres, and is capable of operating on complex combat fields such as urban environments and is well equipped for all climates, including tropical, desert and arctic conditions. The new compact reprogrammable electronics suite installed in the missile allows the system to be easily upgraded with new software.

With more than 1,600 RBS 70 launch and guidance units and more than 17,000 missiles sold, the user's experience with RBS 70 is that it is "easy to use, quick to reload and fast to deploy".

Sayan Majumdar

Successful 2016 for Pilatus



With sales revenue of 821 million Swiss francs, performance in financial 2016 was better than expected. Operating earnings totalled 89 million Swiss francs after deduction of Research and Development investment of 101 million Swiss francs. 56 additional jobs were created across the Group as a whole. 117 aircraft were delivered to customers and the PC-24 development programme is proceeding according to plan.

Notwithstanding a drop in sales revenue compared to the record years of 2014 and 2015, financial 2016 was a successful year for Pilatus, and exceeded expectations. Total sales amounted to 821 million Swiss francs, with operating earnings at 89 million Swiss francs. Orders in hand as of the end of the year under report are at a comfortable 1.7 billion Swiss francs – not including sales revenue from the PC-24!

In 2016, their General Aviation operations contributed 56 percent of total sales; this is the first time this business unit has accounted for the largest share since 2012. Sales of the PC-12 NG were up 30 percent on the previous year, with 91 aircraft compared to 70 in 2015 – this in an environment in which all the major business aircraft manufacturers have had to contend with stagnating or declining sales figures.

The French Air Force opted for the PC-21 Training System towards the end of 2016. The 17 PC-21s on order will be used for pilot training in preparation for stepping up to the Rafale fighter. The Royal Jordanian Air Force also ordered a further two PC-21s, as did QinetiQ, the British firm behind the Empire Test Pilots' School. These three orders for Government Aviation, the other business pillar, represented a total value of over 300 million Swiss francs.

The three PC-24 prototypes have flown 1,500 hours to date. Finalisation of the PC-24's aerodynamic design and systems was the final step in selecting the definitive PC-24 configuration for certification. This was then used as the basis for the P03, the first representative prototype, and for the start of series production, which is already underway.

PC-12 NG is 2016's "Best-Selling Turboprop Business Aircraft"

Delivery of 91 PC-12 NG single engine turboprops in 2016 make it officially the top-selling turbine-powered business aircraft in the world. With 91 aircraft delivered to customers around the world in 2016, the PC-12 NG outpaced sales of all other individual models of turbine-powered business aircraft.

In mid-2017, Pilatus will deliver the 1,500th PC-12. New features in the 2016 PC-12 NG increased cruise speed to 285 KTAS (528 km/h), reduced cabin noise levels, offered updated interior design options, and featured more than a dozen drag reduction changes to the airframe, increasing both range and speed.



500th Eurofighter Typhoon delivered to the Italian AF



The 500th Eurofighter Typhoon has been delivered to the Italian Air Force during a special ceremony held at Leonardo Aircraft Division's Turin site. Lt Gen Gabriele Salvestroni, Logistic Commander of the Italian Air Force, took delivery of the aircraft in the presence of Filippo Bagnato, Leonardo Aircraft Division's Managing Director, Volker Paltzo, Chief Executive Officer of Eurofighter Jagdflugzeug, Peter Schmidt, Deputy General Manager of NETMA, and representatives from the Eurofighter partner nations and partner companies.

Volker Paltzo, Chief Executive Officer of Eurofighter Jagdflugzeug GmbH, stated: "The 500-strong Eurofighter Typhoon fleet represents one of the largest and most capable fighter fleets in the western

hemisphere, and will be the backbone of European airpower for decades to come. This handover is a great testament to the programme's success, and I firmly expect to see the fleet grow further as our partner companies continue to pursue opportunities for more orders internationally."

Filippo Bagnato, Leonardo Aircraft Division Managing Director, said: "We are very proud to deliver the 500th Eurofighter Typhoon produced to the Italian Air Force. The Eurofighter Typhoon is the largest collaborative industrial programme in Europe, is a successful and significant contributor to the nation's economic wellbeing, employing high-skilled workers and generating thousands of high-value manufacturing and engineering jobs. We are now fully committed to completing

deliveries to the Italian Air Force, to develop the capabilities of the aircraft, and to the activities envisaged by Kuwait's contract, while continuing to pursue a number of significant market opportunities around the world."

The first Eurofighter was delivered to the UK Royal Air Force at the end of 2003. The 100th Eurofighter was delivered to the Royal Air Force in September 2006. The 200th aircraft was handed over to the German Air Force in November 2009. The 300th aircraft was delivered to the Spanish Air Force in October 2011, and the 400th to the German Air Force in December 2013.

The aircraft has demonstrated, and continues to demonstrate, high reliability across the globe in all climates. It has been deployed on multiple occasions on Baltic Air Policing duties with the Spanish, German, Italian and UK air forces and has been combat proven during operations in Libya, Iraq and Syria.

Through a series of continual enhancement steps, new capabilities are being added to the aircraft, with test and integration activity currently underway for advanced beyond visual range air-to-air missile Meteor, the precision guided cruise missile Storm Shadow and the precision attack missile Brimstone. "The integration of these weapon systems will ensure Eurofighter Typhoon maintains its position as the most capable, agile and reliable swing-role fighter available on the international market today", stated the company.





RONNEBY'S GRIPENS

Sweden's No. 171 Squadron and its JAS 39 fighters

On 17 September 2014, two Sukhoi Su-24 fighter-bombers (NATO reporting name: *Fencer*) operating out of the Russian military enclave of Kaliningrad violated Swedish airspace close to the island of Öland in the Baltic Sea, having previously skimmed Polish international waters at low level. Although the aircraft flew only about one kilometre inside Swedish airspace for around 30 seconds, the Swedish Foreign Ministry and Government viewed the incident as the “most serious” Russian violation of Swedish airspace in eight years.

In response to increasing air activity by Russian Aerospace Forces in the Baltic area and the large number of air policing missions flown by NATO's Baltic Air Policing fighters based in Lithuania and Estonia, as well as the Finnish and Swedish Air Forces, the *Flygvapnet* (Swedish Air Force) then deployed two JAS 39C Gripens to Visby Airport on Gotland, Sweden's largest island in the Baltic Sea. On 28 October 2014 a large Russian formation, consisting of two MiG-31s, Su-34s, one Su-27 and two Su-24s, transited over the Baltic Sea to Kaliningrad. Although a

flight plan had been filed and all aircraft used their transponders in accordance with international regulations, no radio contact could be established with the transiting aircraft, prompting immediate response by NATO BAP fighters and various Scandinavian and Baltic air forces. Finally, in late October, the suspected presence of an unidentified foreign underwater object in the Stockholm's Kanholmsfjärden archipelago triggered a ‘full resource’ search by the Swedish Navy, combined with the creation of a ‘no fly zone’ over the search area, clearly illustrating Sweden's unease with the ‘resurrected’ Cold War-style military tensions over the Baltic Sea. One of Sweden's main assets to deter foreign provocation is a capable – but gradually downsized – air force, flying Saab JAS 39 Gripen fighters with four operational fighter squadrons based at Luleå-Kallax (in the north) and Ronneby-Källinge (in the south).

Since 2005, 171 Squadron, later joined by the co-located 172 Squadron, operates Sweden's most-modern JAS 39C/D Gripen as part of F17 ‘Blekinge Flygflottilj’ (Blekinge Wing) at Ronneby-Källinge air base in the province of Blekinge.

The Cold War, ‘Peace Dividend’ and multinational operations

Being neutral during World War II, the Swedish Air Force developed into a unique but powerful fighting force during the post-war era. In the sixties the Swedish Air Force had some fifty frontline squadrons, dispersed all over Sweden and equipped with a large number of domestically designed and manufactured fighter aircraft. Generations of Saab aircraft (J32 Lansen, J35 Draken and J37 Viggen) thundered over Swedish skies, as part of a modern fighting force able to deter any foreign aggression. If needed, all squadrons and their fighter, ground-attack and reconnaissance jets would leave their peacetime bases to ‘blend into’ the Swedish countryside, deploying to and operating out of reserve airbases and highway airstrips, well masked by the wooded countryside.

With traditionally friendly relations among its Scandinavian and NATO neighbours, Swedish military attention was focused on the east, confronted with a sizeable and powerful Soviet and Warsaw Pact air and sea capability on the eastern

shores of the Baltic Sea. This military interest proved to be mutually important, illustrated by the infamous October 1981 'Whiskey on the Rocks' incident, in which a Soviet *Whiskey*-class diesel-electric submarine, likely on a surveillance mission, ran aground some two kilometres from the Swedish Navy's main base at Karlskrona (close to Ronneby), well within Swedish territorial waters.

Air aggressions from the east were simulated by large number of Saab Sk60 trainers, transformed during exercises into light attack aircraft, flying halfway into the Baltic Sea before turning back to the Swedish homeland to test responses of various air defence assets (the air operations centre, ground based radars and fighter units). Fully aware that quick response and overall situation awareness was vital to detect and destroy possible (air) threats, the Swedish Air Force quickly developed tactical ground-based and airborne datalink systems.

The end of the Cold War, defusion of military tension in the Baltic area after the independence of the Baltic States, and the huge financial 'Peace Dividend,' triggered by military spending cutbacks all over the world, saw a progressive decrease in the overall size of the Swedish Armed Forces.

Numerous air bases and their tenant wings were disbanded and a large number of reserve-bases were de-activated. While initial plans were for five fighter wings (F4, F7, F10, F17 and F21) to receive Sweden's last Cold War fighter, the Saab Gripen, eventually only two operational wings (F17 and F21) and one training wing (F7 at Sätenäs) would operate these aircraft.

Similar to other European forces, the Swedish Air Force was pushed to justify its existence in a changing world and began to look beyond its national borders, joining multinational peacekeeping and enforcing operations (such as *Unified Protector* over Libya in 2011) with great tactical and military success.

Becoming leaner by optimising the technical capabilities of its ground-based and airborne assets, and increasingly 'out-of-area' orientated, the Swedish Armed Forces were taken by surprise in January 2013 when the Russian Air Force sent waves of bombers over the Baltic Sea in a large-scale simulated attack on Stockholm. During the Cold War a similar exercise would have triggered a well-oiled chain of defensive reactions, but unfortunately in this case,

not a single Swedish aircraft was scrambled to intercept the incoming aircraft!

Negative response in the national press and public criticism urged the Swedish Air Force to rethink its operational doctrine with a shift once more toward national defence. The Swedish Air Force's four operational Gripen squadrons remain Sweden's most important airborne deterrent.

171 Squadron (1st Division, F17)

Formed on 1 July 1944 as the 1st Division (codenamed *Qvintus Röd*) of the Ronneby-Kallinge based F17 *Blekinge Flygfloottillj*, 171 Squadron began as a maritime attack unit but was re-roled several times in its operational history, finally becoming a JA 37 Viggen fighter unit in 1993.

F17 was planned from the start to become an operational Gripen unit, but the conversion was accelerated after Swedish budgetary cutbacks reduced the number of Gripen fighter wings. In 2002 both F17 squadrons started their conversion on the JAS 39, receiving aircraft from the disbanded F10 Wing at Ängelholm, which was finally disbanded on 31 December 2002, having operated A-model Gripens from 2000 onward.

In 2005, F17 received the updated multirole JAS 39C/D Gripen, which have since then been continuously upgraded, and are now operational with the latest avionics software, allowing use of the most modern weapons, such as IRIS-T IR short-range air-to-air missiles, GBU-49 Enhanced Paveway, and the MBDA Meteor BVRAAM.

The multirole capabilities of the JAS 39C enable 171 Squadron to perform a

wide range of operational missions : air defence, air-to-ground strike, anti-shipping and reconnaissance. For air defence/policing missions the Gripens are armed with wingtip-mounted IRIS-T heat-seeking missiles and AIM-120C AMRAAMs, supplementing the internal single-barrel Mauser BK27 20mm cannon. To gain and retain their air-to-air gunnery qualifications, frequent gunnery sessions are organised over the Baltic Sea using acoustic and wooden targets towed by yellow-coloured Learjet 35As of Saab Nyge Aero, based at Nyköping.

For air-to-air missions, the Swedish Air Force's Gripen fleet is supplemented by two Saab S 100D Argus ASC (Airborne Surveillance and Control) aircraft, equipped with the ASC-890 Erieye system, operated by 172 squadron based at Linköping-Malmen. These airborne surveillance aircraft (as well as all JAS 39 Gripens) are linked to the Swedish Air Force 'StriC' command and control system which is the heart of a forces-wide web of information gathering assets, ranging from UAVs, S 102B Korpen SIGINT aircraft, ground based air defence radars to desk-bound information warfare units. This 'Advanced Air Battle 2020' concept, triggered by the Swedish Armed Forces Dominant Battlespace Awareness' (DBA) doctrine, is based on network-based information gathering by the ASIS high-capacity data fusion network and free access to this tactical information at all levels.

During the advanced operational training course, young Gripen pilots of 171 Squadron often train with experienced



171 Squadron pilots at Ronneby

Gripen pilots, flying Ronneby-based Sk60A trainers from F17's *Sambandsflygrupp* (Liaison Flight). Both sets of pilots are familiar with each other's aircraft, and the 'bandit' will use the superior slow-speed horizontal manoeuvring capabilities of the older Sk60 to force the young Gripen pilot to exploit his technically superior and more capable fighter to make the aerial fight a three-dimensional battle. These individual engagements are short, and both aircraft return to their starting positions for multiple such fights in a mission.

To allow active participation in international military operations and to improve interoperability with coalition air forces, the Swedish Air Force decided in October 2005 to install in the majority of its Gripens and ASC aircraft the NATO-standard MIDS Link 16 tactical datalink – in addition to the Swedish Tactical Information Datalink System (TIDLS) already in use.

Young pilots, assigned to 171 Squadron after training at the 1st Division of the Sätenäs-based F7 Wing, the SwAF's Gripen



Gripen Cs on the apron

conversion unit, start operational tactical courses with air-to-air tactics taught by the squadron's instructors over a period of 20 to 30 missions.

For air-to-ground strike, the SwAF Gripen squadrons uses modern weapons

and sensors to execute offensive counter air, air interdiction and close air support missions in support of the Swedish Army : 250 kg GBU-12 laser-guided bombs and more modern GBU-49 GPS- and laser-guided Paveway IIs, guided by state-of-



Ronneby Gripens in flight over Sweden

the-art Rafael Litening III targeting pods. These modern LGBs replace the older AGM-65A/B Maverick missiles (called Rb75 in SwAF service).

Frequently, pairs of 171 Squadron pilots take-off from Ronneby for air-to-air gunnery practice at the nearby sea-side Ravlunda range. Guided by a forward air controller on the ground, one Gripen will attack a target with its Mauser cannon, while the wingman will scan the area for ground and air threats.

Live LGBs can be dropped during dedicated air-to-ground deployments to the vast Vidsel air base, located in Sweden's extreme north. Vidsel is a 1650 sq km uninhabited forest and marshland area housing the North European Aerospace Test Range, owned by the Swedish Defence Material Administration, and host to frequent deployments of Swedish and international fighter squadrons (and aerospace companies) for testing of platforms and weaponry in realistic tactical conditions.

In these remote and uninhabited areas, Gripen pilots are allowed to fly as low as 600 feet in the summertime and 100 feet during winter. While these tactical flying rules are followed in most parts of Sweden, both Ronneby squadrons frequently send pilots north to their colleagues at F21 at Luleå-Kallax for low-level training in order to reduce noise complaints in the more populated southern areas.

The vast almost unlimited airspace over Sweden's north allows F21 to organise weekly cross-border training with F-16AM Fighting Falcons of the Royal Norwegian Air Force and F/A-18C/D Hornets from the Finnish Air Force, staging complex but realistic air war scenarios. Ronneby squadrons participate whenever possible, so as to complement their regular training exercises with Royal Danish Air Force F-16AM Fighting Falcon squadrons and the NATO Baltic Policing contingent based in Lithuania. Pilots of 171 Squadron frequently practice air-to-air refueling in the SwAF training areas over the Baltic Sea with Swedish C-130H Hercules (locally designated Tp84T) out of Sätanäs air base. The Gripen's aerial-refueling capability was operationalised in mid-2009, to enable participation in international out-of-area operations and boost the flexibility of the Gripen fleet. Nowadays, most Gripen pilots are qualified to receive fuel from Swedish

Tp84T Hercules, USAF KC-135s, KDC-10s of the Dutch Air Force and German Luftwaffe Airbus MRTTs.

The Gripen's strike role is supplemented by an important maritime strike and anti-ship warfare capability, safeguarding Sweden from maritime invasion and protecting maritime sea-lanes of communication. The prime weapon in this role is the Saab Bofors Dynamics RBS-15 subsonic fire-and-forget sea-skimming missile, capable of being launched at very low level. The RBS-15 allows Gripen pilots, usually operating in four-ship attack formations, to stay undetected before and after launching their lethal sea-skimming weapons at maritime targets. In 2004, Saab began development of a land-attack version of the RBS-15, using GPS and a derivative of the Gripen's terrain-referenced navigation system, improving overall accuracy.

To complement its air-to-air (*Jakt*) and strike (*Attack*) capabilities, the JAS39 Gripen is also used for reconnaissance missions (*Spaning*, completing the multirole 'JAS' acronym) within the SwAF, using the modern centreline-mounted SPK39 (*Spaningskapsel 39*) tactical reconnaissance pod. Developed by Saab Avionics and Danish defence firm Terma, the SPK39 houses electro-optical and infra-red sensors, a solid state data recorder and a datalink to share images within the SwAF network. Gripen pilots can also use their Litening targeting pods for target reconnaissance. The JAS39's excellent reconnaissance and battlefield awareness capabilities were well proven during Sweden's participation

in *Operation Unified Protector* over Libya in 2011, shooting countless vital reconnaissance pictures with their SPK39 and Litening III pods (see *Vayu IV/2012*).

International Operations

Since the end of the Cold War, Sweden has placed a large emphasis on international peacekeeping operations. In 2000 the Swedish Air Force Rapid Reaction Unit (SWAFRAP) was established, to be placed under the direction of the United Nations, European Union or NATO's *Partnership for Peace* programme. Initially a squadron of AJSF 37 Viggen fighters and a C-130H Hercules were assigned to SWAFRAP. The withdrawal of the last Viggens passed the rapid reaction task to the JAS 39 Gripens from 2004 on, until SWAFRAP was disbanded in late 2007.

On 1 January 2008 the Nordic Battle Group was created, composed of military forces from Sweden, Estonia, Norway and Finland. From the start Sweden assigned eight JAS 39C/D to the NBG to be known as *Stridsflygenhet 01* (SE01, Combat Aircraft Unit 01), staffed by pilots and ground crew of F21 at Luleå. Since then, elements of F21 and F17 – including 171 Squadron – are assigned to the NBG on rotational basis, with 171 Squadron serving under NBG in 2011 and 2015.

The Swedish Air Force SE-concept was first tested when seven Gripens of 171 Squadron and 100 support personnel deployed to RAF Fairford in England, to practice and evaluate their capabilities to operate as independently as possible from



A pair of Ronneby Gripens in formation

homeland support from an out-of-area base. During this exercise, named *Crown Condor*, the Swedish pilots worked along with No. 12 (Bomber) Squadron of the RAF, flying Panavia Tornado GR.4 aircraft.

Frequent training detachments are also deployed to the UK, USA and the Netherlands. Swedish Gripens frequently participate in the RAF-led *Joint Warrior* maritime exercise series out of RAF Lossiemouth in Scotland and visit UK-based fighter units (USAF 48th Fighter Wing with the F-15E Strike Eagle) to train together in complex scenarios, making use of the dedicated electronic warfare ranges in the United Kingdom.

Joint F21-F17 contingents participated in the well-known USAF *Red Flag* exercises out of Nellis AFB in Nevada and Elmendorf AFB in Alaska, making enthusiastic use of the local flying areas to exercise tactical profiles and training against range simulated air defence systems and USAF aggressor units. For financial and logistical reasons transcontinental training is not always feasible, so the annual *Frisian Flag* exercise organised by the Dutch Air Force out of Leeuwarden Air Base in the Netherlands proves to be a valuable alternative.

The sole constraint during these valuable international training excursions is Sweden's 'non-NATO' status, which hampers Swedish access to 'NATO-only' information that is valuable for planning and execution of exercise missions.

The NATO-led *Operation Unified Protector* (OUP) over Libya in 2011 marked operational international debut

of the Swedish Gripen force. Following a decision by Swedish Parliament on 1 April 2011 to join OUP, and supported by Denmark as a NATO 'sponsor,' the first Gripen detachment (FL01), crewed by pilots of 171 Squadron, was flown to NAS Sigonella in Sicily, making a technical stop at Kecskemét, a Hungarian Air Force JAS 39C/D base. The first two-ship missions to monitor and enforce the no-fly zone over Libya were flown by FL01 out of NAS Sigonella a mere five days later, on 6 April. The Gripens were supported by a SwAF Tp84T tanker for air-to-air refueling, and the Swedish participation was given the codename *Operation Karakal*.

Becoming familiar with the Gripen's outstanding reconnaissance capabilities, NATO quickly requested Sweden to re-role its Gripen aircraft into the reconnaissance role, with great success. At the same time the Swedish Parliament expanded the SwAF participation and release restrictions on the type of operations performed by the Gripen pilots. The FL02 contingent was staffed by pilots of the Luleå-based 212 Squadron but lacked the Tp84T tanker support, and therefore utilised NATO tankers (French KC-135FRs). OUP missions were counter-air oriented recce missions 'screening' airfields and mobile Surface-to-Air Missile (SAM) sites.

In total, *Operation Karakal* involved a total of 650 operational sorties (and some 2,000 flying hours) flown over seven months, generated numerous reconnaissance reports that were invaluable for mission planning during OUP.

Once back at Ronneby, the operational life of 171 Squadron returned to its traditional pace : beginning with the weather briefing at 0720h before heading to their squadron to prepare their individual or element-training mission. To reduce noise complaints, Ronneby pilots are not allowed to take-off before 0850h and need to stop flying around 1630h local time for daytime missions, and 2200h during night flying. Depending on the operational qualification, training phase and staff function of various pilots, 171 Squadron on average sees each pilot fly around 100-160 flying hours a year.

Both Ronneby squadrons serve as Quick Reaction Alert (QRA) units on 24/7 standby rotation, to be able to launch when needed to intercept foreign (mostly Russian) military fighters or reconnaissance aircraft over the Baltic Sea. Since 2004, SwAF Gripens frequently encounter NATO fighters based at Šiauliai in Lithuania as part of NATO's Baltic Air Policing mission, safeguarding the airspace of the Baltic States (Estonia, Latvia and Lithuania) from foreign incursions. To standardise and train prevailing air policing rules of engagement, frequent Baltic Region Training Exercises (BRTEs) are organised. The exercises have helicopters or transport aircraft of one of the Baltic States simulating a communications loss, forcing NATO or Swedish fighters to launch and intercept the intruder. On occasion, the Ronneby squadrons deploy to Šiauliai during a BRTE and make use of the occasion to perform some additional DACT flying with the Šiauliai-based fighters, depending on the BRTE scenario and time availability.



Gripen C showing its centreline tank, six wing stations, cannon and dedicated targeting pod station to good effect in flight

Although Swedish and NATO air policing interests over the Baltic Sea are more or less similar – deterring and intercepting Russian reconnaissance flights and assisting aircraft with communications issues – each party still independently evaluates the necessity to launch air policing fighters.

The combination of high professionalism of SwAF fighter pilots, capabilities of the JAS 39C/D, and the unlimited airspace in northern Sweden makes Swedish Gripen units much sought after sparring partners during international air exercises. An annual Nordic Air Meet is organised out of Luleå Air Base, attended by the various Gripen squadrons and numerous foreign fighters. 2012's Nordic Air Meet saw active participation from Swiss and Finnish F/A-18C/D Hornets, USAF and Royal Danish Air Force F-16 Fighting Falcons and RAF Tornado GR.4 aircraft, assisted by USAF KC-135 tankers.

In April 2012, Ronneby hosted the first *Lion Effort* exercise, attended by pilots of all five air forces flying the Gripen (Sweden, Czech Republic, Hungary, South Africa and Thailand). During this weeklong Gripen exercise, multinational COMAOs (Combined Air Operations) were flown to test integration and operation the individual avionics suites of the various national Gripen variants. Integration of the SAAF Gripens for example, which are equipped with their own domestic avionics and radio suites, proved quite a challenge.

More special was the SwAF participation in the 18-day NATO Iceland Fighter Meet 2014, organised at Keflavik air base in February 2014. 'Sponsored' by the Royal Norwegian Air Force, SwAF JAS 39C/D Gripens and Finnish F/A-18C/D Hornets joined RNoAF F-16AM Fighting Falcons to train offensive and defensive counter air missions over the northern Atlantic Ocean. All attacking and defending formations were mixed Gripen-Hornet-Falcon formations, in order to train interoperability between the various air forces. In the event of actual incursions by foreign military aircraft during IFM 2014, however, only the RNoAF F-16AM Fighting Falcons were allowed to make operational intercepts.

The Gripen's Future

Upgrading fighter aircraft to remain is an omnipresent desire of all air forces, constrained by equally omnipresent financial restrictions! The Swedish Air

Force has continuously kept its fighter fleet up to date with a combination of new build aircraft, and rebuild/upgrade of older Gripens to more modern standards.

Although the Swedish Air Force had initially planned (and paid for) 204 JAS 39s, it today aims at an operational Gripen fleet of 100 fighters – 75 single-seat C-models and 25 twin seat D-models. Of the 120 A/B models originally delivered, a total of 18 JAS 39A and 13 JAS 39Bs were modified into more advanced C/D-models. Sixteen additional A/B-models were used to rebuild Hungary's fourteen C/D Gripens.

The Swedish Air Force is now starting to upgrade its current C/D fleet to the MS20 software standard, allowing integration of the new MBDA Meteor BVRAAM and Boeing's GBU-39 Small Diameter Bomb. Night operations with the SPK39 modular reconnaissance pod will be made possible and new Chemical, Biological, Radiological and Nuclear (CBRN) protection for the pilot will be integrated together with an automatic Ground Collision Avoidance System (Auto-GCAS).

In December 2013, the Swedish Defence Material Administration, responsible for all Swedish military procurement, contracted Saab to commence conversion of sixty Gripen C to the new generation Gripen E variant over a 13-year period (2013-2026) under a \$2.5 billion agreement (*see Vayu I/2014*). The SwAF's JAS39D aircraft will remain in service given their suitability to act as lead-in trainers for the E-models. Subsequent revisions to the agreement saw the number of Swedish E-models increased, and then on 11 June 2014, the Swedish Parliament elected to cancel the upgrade programme and to procure new-build E-models (*see Vayu IV/2014*).

For years to come the capable, nimble and continuously updated JAS 39 Gripen will remain Sweden's and 171 Squadron's main airborne fighter asset. Easy to operate from peacetime airbases and wartime road bases alike, the SwAF Gripen fleet will be a force to reckon with... and a valuable partner during joint international operations with allied air forces.

Stefan Degraef and Edwin Borremans



Clockwise from top left: 171 Squadron patch, Iceland Air Meet exercise patch highlighting the three participant aircraft types (Gripen, F-16, F/A-18), Gripen Weapon Instructor Course patch, and 2011 Operation Unified Protector patch showing Gripens and C-130 tanker



Greek Recce Phantoms Bow Out

The Hellenic Air Force retired its McDonnell Douglas RF-4 Phantom IIs on 5 May, but not before the service opened its doors to photographers and reporters to visit the type's home base at Larissa for a final look at recce Phantoms in Greek colours.

Lt Col Dimitris Papadimitriou, with over 2,000 flight hours on the Phantom, is evidently proud of the squadron he commands, and keen to explain its history: "348 Tactical Reconnaissance Squadron is one of the oldest and most historic squadrons in the Hellenic Air Force. It was set up initially as 348 Tactical Reconnaissance Flight under the 112 Combat Wing in 1953."

Back then, it was operating with F-84G aircraft which had been altered to perform tactical recce missions. Two years later 348 Flight became a Squadron, called 348 *Mira Taktikis Anagnoriseos* (MTA, Tactical Reconnaissance Squadron) 'Mátia' ('Eyes'), and was provided with RT-33 and later RF-84F aircraft.

Lt Col Papadimitriou also explains why there are two visually distinct sets of RF-4E Phantoms operating in the squadron. "In 1979 The RF-4E aircraft entered the inventory of the 348 Tactical Reconnaissance Squadron. They were new aircraft supplied by the USAF, and served with the same [brown and green] camouflage pattern they were delivered in. In the summer of 1993, the Hellenic Air Force received 27 more RF-4E aircraft from the German Air Force, which had a much more dark green camouflage pattern, and these were not repainted."

An ex-German RF-4E in the darker camouflage takes to the sky



Analog aircraft in a digital world

The RF-4E Phantom II is designed for tactical reconnaissance. One of the squadron's instructor pilots, Captain Nik Sofologis, call sign *So'ph'os* (meaning 'wise man,' with special emphasis on the 'ph' for Phantom!) talks about the cameras: "The RF-4 is an old aircraft which uses analog cameras that record frames on black and white film. When you see the aircraft, you'll notice three glass panes near the nose, two on each side and one on the bottom. Those are the three camera stations." Combinations of photographic equipment can be equipped, depending on the mission. Two of the camera types are built by CAI, the KS-87B classic camera, and the KS-127A Long Range Oblique Photography (LOROP) camera. For panoramic views, KA-56E cameras are used for low altitude, and KA-91B for high altitude. For specific day or night missions, near-infrared AAD-5 cameras can be used.



An RF-4E is marshalled out of its shelter at Larissa



The 66-inch (1676-mm) LOROP camera in particular impresses Captain Sofologis. "It's a big camera, it takes all the stations. It was used to take strategic pictures from a great altitude... I can remember 35,000ft (10,668m). We can get great pictures with good ground resolution. We are able to zoom in very far, and find in the frame what we need."

The digital successor

After retirement of the RF-4, reconnaissance tasks will be performed by F-16s equipped with recce pods. Captain Sofologis tries to make a comparison between the RF-4, and the Goodrich DB-110 digital reconnaissance pod under the F-16: "It is fully autonomous with the ability to take long range photos. Images are recorded on a solid-state hard drive. It is great because it can take pictures in the infrared spectrum using electro-optical sensor technology during night or day operations to see extra details on targets that we need."

But still, explains *So'ph'os*, the RF-4 has an advantage over the F-16: "In the F-16 you must plan the exact route on the ground and you have to follow that specific route. When I get to a specific waypoint on my route, the camera opens automatically and shoots photos from these areas, like a box with overlaps." This means the F-16 does not have flexibility with the cameras the way the RF-4 does.



An RF-4E in flight, trailing the Phantom's characteristic smoke

In the RF-4, the co-pilot is primary user of the camera, and he can operate the camera to take the pictures at the point he wants. "The backseater is the main operator of the cameras. The pilot in front has two means of detecting where he's taking pictures. In front there is a viewfinder, and on the sides you had circles. If the target you wanted was inside the circle, that is the frame. In the Phantom, we can take a photo of anything we want."

With the F-16 and the DB-110 recce pod there is a possibility to send low-resolution images via data link to a ground station. For full resolution pictures, however, the aircraft must land and download the files, as these are too large to transfer wirelessly.

The RF-4 has been in service for a very long time, and it is getting harder to operate in a modern environment. Captain Sofologis states: "Generally speaking, it is a great aircraft, but the big disadvantage is that it lacks electronics. Nowadays, we are trying very hard to follow new tactics with the 2nd generation Phantom, while a large part of the Air Force uses 4th generation aircraft. If you want to use the RF-4 to the limits, you must try very hard."

Missions

The primary role of 348 Squadron is to perform tactical reconnaissance according to the needs of all three branches of the Hellenic military. "The experience from recent combat situations has shown that the success of modern operations does not depend on the amount of armed forces, but on the effective combination of methodical and efficient reconnaissance," says Squadron Commander Lt Col Papadimitriou. "The ability to perform reconnaissance missions gives substantial strategic advantage

to a country by providing invaluable information for mission planning and target recognition. The planning of combat attack missions largely depends on the amount of information collected by aircraft during recce missions."

Recce missions can also be flown to provide battle damage assessment after strike aircraft have released their weapons to a target. "After a specific time we take photos for further analysis about the functionality of the attack and destruction of the target," says Captain Sofologis. "The purpose of the



An RF-4E in the original brown-and-green camouflage seen trailing a brake parachute



Pre-flight checks underway on an RF-4E, with two of the three camera apertures clearly visible on the nose

photos is for our staff to see if an extra group of forces has to re-attack this specific target or if we achieved the desired effect on the target.” Lt Col Papadimitriou adds: “During critical periods the 348 TRS is the first Squadron to depart and the last to land.”

The unit also carries out missions to the benefit of social services such as photographing fires. Captain Sofologis recalls one of those missions: “There was a wide spread fire the civil officers wanted to see where the border line of the fire was, so with our cameras we were taking pictures, making a mosaic of the area. In two hours after the landing they had a clear image of the interest area.”

Another use for the RF-4 was finding water: “The IR camera had the opportunity to help in finding water in some areas that didn’t have enough water. In one city, it was very helpful.”

But the RF-4 had an electronic warfare task too. Making use of the ASTAC pod,

an airborne electronic reconnaissance system, emissions from land-based radars and weapon systems could be intercepted and analysed. With the ASTAC pod, targeted radar emitters could be located and identified precisely and quickly in order to prepare future strikes. Captain Sofologis clarifies: “We were using trigonometry to find the geographic position of the emitters. It was a useful tool to extract the electronic order of battle of the enemy.”

Another non-recce assignment of the RF-4 Phantom was the dispensing of aluminum chaff via the ALE-40 dispensers. “We would make corridors to jam enemy radars to produce false targets, or to damage or obscure the enemy’s radar picture in order to blind or distract the enemy.”

“Beautiful Experience”

When pilots are asked about the experiences they have had in the recce Phantoms, they smile. “We are famous for low level

flying. Low level navigation is the only way for the RF-4 to avoid detection by enemy radar, so the ground is our friend. Personally speaking, we have a lot of beautiful experience from low level navigation.” They all love the Phantom very much, and are sad to see them go. Lt Col Sofologis remembers: “When I was younger, I was very impressed by what our cameras could do, and how much the Air Force was based on this aircraft. So much intel about enemy forces could be gathered. I was also impressed, because it’s great to think that an aircraft that was designed in the 1950s has all these opportunities. It can take pictures traveling up to 600 miles an hour from altitudes up to 30,000 feet.”

Captain Sofologis is not alone: the RF-4s will be missed by pilots and enthusiasts alike !

*Text: Jeroen van Veenendaal
Photos: Roelof-Jan Gort and Jeroen van Veenendaal*



F-16s equipped with DB-110 pods (not pictured here) will replace the RF-4E in the recce role

Frisian Flag and EART 2017



A German Eurofighter and Dutch F-16 readying to depart Leeuwarden

At Leeuwarden air base in the Netherlands, the annual *Frisian Flag* exercise was held from 27 March to 7 April 2017. The two weeks saw a mix of air-to-air and air-to-ground air warfare scenarios executed by the participants, which included ten Eurofighters from the German Luftwaffe's 31 TLG at Nörvenich, eight USAF F-15Cs from the 122th Expeditionary Fighter Squadron (with aircraft from the Florida and Louisiana Air National Guard), twelve Dutch F-16s from 312, 313, and 322 Squadrons at Volkel and Leeuwarden, Belgian F-16s from 349 Squadron at Kleine-Brogel, RAF Tornado

A Louisiana ANG F-15 about to touch down at Leeuwarden



Mirage 2000D coming in to land

GR4s from 31 Squadron at Marham, Portuguese F-16s from the Monte-Real air base, French Mirage 2000Ds from Nancy-Ochey, a single Dutch C-130 acting as a 'slow-mover' to be escorted by the fighters, and a civilian COBHAM Dassault Falcon 20 for electronic warfare training.

Realistic international cooperation is one of the key aims of *Frisian Flag*, as lessons learned from recent Afghanistan and Libya operations have shown. Many international



A Portuguese F-16 gets airborne for a Frisian Flag mission

operations are conducted by multinational taskforces, with different aircraft types, with different tactics, doctrines and training-levels, with different command-chains and different air-refueling procedures and certification. Exercises like *Frisian Flag* supply a low-cost opportunity to train for multinational operations.

Each day had two missions, flown by the same aircraft but with different pilots. The missions grew more and more complicated through the course of the exercise, and all participating countries had opportunities to play the role of 'mission commander' for various missions, bringing in their specific national tactics, doctrines and experiences from previous exercises and conflicts.

Preparations for the morning missions commenced the day before and ended with a mass-briefing early in the morning, while the afternoon missions commenced planning early in the morning and ended with a mass-briefing just before take-off. Missions flow included offensive and defensive air-to-air missions and offensive and defensive air-to-ground missions twice a day with some 40-50 aircraft airborne each mission.

The Dutch 322 TACTESS (Tactical Training Evaluation and Standardisation Squadron) has organised the *Frisian Flag* exercise and its predecessors for over 20 years. The main task of 322 TACTESS is to standardise Dutch operational F-16 tactics and doctrines.



RAF Tornados line up before a mission

Tanker training

In parallel with *Frisian Flag* 2017, the multinational refueling training exercise EART 2017 was held at Eindhoven air base in the southern part of the Netherlands. These tankers participated as refuelers for *Frisian Flag* aircraft, giving the participating European forces the ability to train with a variety of a tanker and receiver aircraft. The 2017 edition

saw boom-equipped Dutch KDC-10s, hose-equipped German A310 MRTTs, French KC-135 with boom and hoses, and Italy's modern KC-767, also with boom and hoses, available for the *Frisian Flag* fighters, enhancing future interoperability and broadening expertise for both the fast jet and tanker crews.

Text and photos:

Joris van Boven and Alex van Noye



Tankers at Eindhoven during EART 2017: an Italian KC-767 climbs out as a Dutch KDC-10 taxis on the ground



Red Flag: The Ultimate Game!

They say Vegas never sleeps, and this was particularly true during the two-week-long second edition of this year's 'Red Flag' exercise, which wrapped up on 10 March 2017.

“**N**ellis departure, Phantom 41 flight of four Fox 16s on the Dream Four departure climbing flight level 190.” This radio call was made by the lead Royal Netherlands Air Force F-16 heading a four-ship flight climbing out of Nellis Air Force Base (AFB) for the first sortie of *Red Flag* 17-2 during the afternoon of 27 February 2017. Fight’s on!

Nellis and NTTR

Red Flag, a realistic combat training exercise involving air forces of the United States and its allies, is coordinated at Nellis AFB, Nevada, and conducted on the vast bombing and gunnery ranges of the Nevada Test and Training Range (NTTR). It is one of a series of advanced training programmes administered by the United States Air Force Warfare Centre at Nellis and executed through the 414th Combat Training Squadron (CTS). Aircraft and personnel deploy to Nellis for *Red Flag* under the ‘Air Expeditionary Force’ concept and make up the exercise’s ‘Blue’ (friendly) forces. By working together, these Blue forces are

able to utilise the diverse capabilities of their aircraft to execute specific missions, such as air interdiction, combat search and rescue, close air support, dynamic targeting and defensive counter air. These forces use various tactics to attack NTTR targets such as mock airfields, vehicle convoys, tanks, parked aircraft, bunkered defensive

positions and missile sites. These targets are defended by a variety of simulated ‘Red’ (hostile) ground and air threats, normally provided by F-16s of the 414th CTS and occasionally supplemented by USAF T-38s or civilian contractors like Draken International, to give participant aircrews the most realistic combat training possible.



USMC EA-6B Prowlers participated for the last time at a Red Flag exercise

Multinational training

The second edition of *Red Flag* each year is the one in which European forces participate. This year was no exception, and alongside a variety of squadrons from all four branches of the US military the

CH-47 Chinooks from their training detachment in Texas. The German Air Force was scheduled to participate but had to cancel for undisclosed reasons. The 20th Fighter Wing from Shaw Air Force Base, South Carolina was the

“I want everyone who participates to realise that even though we are fortunate enough to have outstanding equipment and weapons systems, it’s the people executing the mission that will ultimately ensure mission success.”



Unique platforms like the E-8 JSTARS are a key part of what makes 'Red Flag' the premier air exercise in the world

Royal Netherlands Air Force (*Koninklijke Luchtmacht*) joined with ten of their F-16s (six from the Netherlands and four from their permanent training facility at Tucson, Arizona), the Spanish Air Force (*Ejército del Aire*) brought eight Tranche-2 Eurofighters and two Lockheed KC-130 tanker/ transports, and the Singapore Air Force sent Boeing

exercise's core unit, meaning 20th FW senior leadership worked closely with *Red Flag* staff to ensure participants were aware of and able to properly leverage the capabilities of Nellis. “The number one objective is integration with partner nations,” said Colonel John Bosone, 20th FW deputy commander and *Red Flag* 17-2 Air Expeditionary Wing commander.

Mission employment

Each day hosts a unique scenario, for example a response to an international superpower that seizes a small neighbouring nation, defending against an attack, addressing a hostage situation or localised regional conflict initiated by a rogue nation. In each case, the exercises represent the reality of the world that confronts



F-16 aggressors serve as 'Red Air' during the exercise

us today. Tactics continue to evolve and participants must be calculative and wary about their approach to unfolding situations. A solo F-16C Aggressor was 'captured' fast and low on the Blue side of the range, and it was noted that the aircraft was trying to lure Blue forces into a pursuit to lead them subsequently into a Red Air ambush. Not simply a scripted exercise, but innovative and dynamic activity challenges reactions and creates tremendous learning experiences in a safe environment. Lt Col Haarsma, detachment commander of the Dutch F-16s, elaborates on the training value during the mission: "The training value for pilots is extremely high. Everything evolves like it could happen tomorrow in real combat situations. The results of the Blue forces in the air during the mission are directly relayed to the aggressors (Red Air). For example, they hear directly if

First and last timers

Red Flag 17-2 was an exercise with some first timers but also the conclusion of a chapter. The US Marine Corps Grumman EA-6B Prowlers of VMAQ-4 *Seahawks* are set for retirement and the unit will stand down during June this year thus ending a long history of Prowler participation in *Flag* exercises. For the Spanish Air Force it was the first time operating their Eurofighter Typhoons some 8,000 km from home in order to demonstrate the ability to deploy far away and to train with the Tranche-2 Eurofighters, particularly in the air to ground role. Considering the fact that a 100 per cent mission available rate was achieved during the exercise, both ground and air crews succeeded in that mission. The introduction of the Lockheed Martin Sniper Advanced Targeting Pod and the new AIM-9X air-to-air missile were milestones for the Royal Netherlands Air Force during *Red*

guided weapons against multiple fixed and moving targets. It gives us more information and thus better situational awareness for current mission requirements."

Enhancing performance

Since its inception in 1975, *Red Flag* has served as the pinnacle of air-to-air combat training for the United States Air Force and its allies. Exercises such as *Red Flag* bear a close resemblance to the way modern conflicts are addressed, as coalitions of a broad number of specialised and international assets. In such cases *Red Flag* training is critical to prepare for such real world deployments. The objective of *Red Flag* has been to provide participants with ten "combat mission" experiences before entering combat and as such greatly increase the performance and survivability of participants. This approach has demonstrated tremendous success in

A Dutch F-16 heads for a night flight



Blue Air shot down aggressors or if bombs were dropped on enemy radar systems. With this information Red Air adjusts their strategy, which means Blue has to be flexible as well. This learning curve is unique in the world."

Flag 17-2 as explained by Lt Col Haarsma: "We received the first AAQ-33 during the first half of 2016. It detects and identifies automatically tracks and laser designates small tactical targets at long ranges. It also supports employment of all laser- and GPS-

ensuring US and coalition forces are the best-trained, most prepared military forces on the planet.

*Text and photos:
Remco Stalenhoef, Stephan van
Geem and Patrick Smitshoek*

Ancient Aviator Anecdotes



Air Vice Marshal Cecil Parker recollects



Type Trainers

Depending upon the context in which it is used, the term 'trainers' can refer to people or to specialist sports shoes or to flight simulators! Fliers world-wide however know it as the generic term used for two-seater aircraft utilised for pilot training ranging from basic to type-trainers of high-performance, single-seat combat aircraft. By design, a trainer aircraft seating can be either tandem or side-by-side, with the pupil generally seated in the front cockpit in the former, or in the left hand seat in the latter.

My generation's association with IAF trainer aircraft began in 1951 in Ambala with basic flying training in the fabric-covered, tandem-seating biplane, the Tiger

Moth, in which the pupil flew from the rear cockpit! In the advanced stage of pilot training we flew from the front cockpit of the all-metal Harvard. Post-commission we moved to the CTU to convert on to the Tempest which had no type-trainer. We were therefore given four dual sorties from the front cockpit of the Spitfire Mk 1X – the trainer derivative of the famous 'Battle of Britain' fighter aircraft. In comparison the Tempest was a far more powerful, heavy and difficult plane to fly; we survived but alas our naval aviator course mate did not. This was the end of our training on piston-engined, tail-wheel aircraft as the Tempest was soon grounded and we moved to a squadron equipped with the very first jets of the IAF.

The Vampire type-trainer was still in the future hence we were briefed thoroughly and, after a ground-run, were launched solo in an aircraft where, for the very first time, the engine, was behind us and we were seated in the nose of the aircraft; we coped! The next aircraft was the Toofani which also did not have a type-trainer but now, with over two years flying experience on Vampire jets, we converted more easily onto this French aircraft with its toe-brakes, wing-tip tanks and higher C of G. At FIS (Flying Instructors' School), we learned to fly from the rear cockpit of the HT-2 and Harvard trainers as well as learning how to teach. As QFIs at the Academy, we imparted knowledge and flying skills to ab initio pilot

trainees on these two aircraft, along with the Prentice, which was the very first side-by-side seating aircraft I had ever flown.

Back to squadron life and ten consecutive years on the Hunter which had a very professionally designed trainer variant with side-by-side seating. A good deal of my instructional flying was from the right hand seat especially at the (Hunter) OTU which I raised and commanded from 1966–69. During this period I also had the privilege of being taken up for an air experience sortie in a visiting Canberra by one of the IAF's legends who happened to be my then station commander. As a station commander myself, I inducted the tandem



seater Polish Iskra trainer into the IAF and which, along with the Kiran trainer, we used for both advanced and applied stages of pilot training. As the AOC of an air base for MiG, I did my Type 69 conversion with duals on the MiG-21UMF and as Commandant of the Air Force Academy flew the prototype HPT-32 trainer.

The non-IAF trainers I flew, as a pupil or for familiarisation, included the F-100F Super Sabre during Exercise *Shiksha* with the USAF in Palam in 1963 (my first experience of a reheat engine); the T-39A Sabreliner in the USA while on course there in 1965 and the BAe Hawk and Harrier T.4 in the UK in 1980. The last two trainer aircraft I flew in the Air Force were the MiG-23UM from Leh and the Jaguar T-2 from Ambala where it all started 35 years earlier! My log book tells me that 35 per cent of my flying hours are as a 'trainer' but, as all (old) pilots know, 100 per cent was experiential learning!

The Tempest in India

On occasion, a reader's response to these anecdotes, spawns another. An e-mail from a Canadian national, of Indian origin, informed me that a granduncle of his (whom he had never met) had lost his life in a Tempest aircraft crash of the IAF in the 1950s. Having read about my link with the Tempest aircraft 65 years ago, he gave me the family name which rang a bell. His relative had been a course ahead of me and died in a Tempest accident in Pune in 1953.

The Tempest IIA served the RIAF / IAF from 1946 to 1953. On 15 August 1947, (then) Sqd Ldr Arjan Singh, DFC had led the first (and last) flypast of 12 Tempests

over Red Fort when our national flag was unfurled for the first time. The aircraft was used in the offensive air support role during the Kashmir war of 1948-49. It was a single seat, single-engine, fighter bomber and our last piston-engine ground attack aircraft before the advent of jets in our Air Force. It was a heavy, powerful and difficult aircraft to fly, as we young newly commissioned pilot officers were to learn at CTU, in late 1952.

The gap between the Harvard trainer and the Tempest was 'bridged' for us by four dual sorties in the Spitfire Mk. IX – the trainer variant of the Spitfire family. The Centaurus engine fitted on the Tempest IIA was prone to engine cuts owing to connecting-rod failures. Midway through our Tempest conversion, owing to engine failure, one course mate successfully force landed on the airfield. A week later this writer was lucky to bail out from another aircraft on fire in the air. A few days later

a third coursemate (a naval aviator), was not so lucky and went down with his aircraft. Similar incidents/accidents were reported from No 4 Squadron in Pune and No 10 Squadron in Barrackpore. This led to grounding of the aircraft, termination of our training and posting to squadrons equipped with the Vampire jets.

In retirement, some years ago, while researching for an article on Indian membership of the *Caterpillar Club*, I requested for and was provided with full flight safety data by Air HQ. The information pertaining to Tempest was sparse but revealing in that, in every fatal

accident, the pilot had gone down with the aircraft with parachute unused. This suggests that there was some basic design flaw that obstructed emergency exit in the air. In fact, the only recorded successful bail out was mine in 1952. However, the family of the late Wg Cdr Sydney Noronha, MVC informed me that he had bailed out from a Tempest safely during the Kashmir operations. In those early years, perhaps records were not maintained too carefully and it is possible that some accidents had not been included in the data given to me. My individual written requests for information to our very senior pilots on this subject, elicited the following response from Air Chief Marshal Arjan Singh, DFC (later Marshal of the Indian Air Force) in his letter dated 21 July 1994:

"I am sorry I have to draw a blank about the purpose of your letter. I have never used a parachute even in practice. At Cranwell, the theory was that in this field you make a mistake only once. The attitude has much changed with introduction of the ejection mechanism. Before that, one was quite scared of using this last resort. However at lower speeds, forced landing was not too hazardous. You were lucky to get away with it in a Tempest, a difficult aircraft to fly and land and much more to bail out from. I cannot think of anyone else who got away with it in an Irwin parachute in the early days of the IAF".

Though the ejection seat has made this issue obsolete, it is hoped that this brief recap of the Tempest in a nascent air force seven decades ago, will offer some explanatory background to a reader in Canada.

25 Years Back

From Vayu Aerospace Review Issue III/1992

Agni Launched

The second launch of India's Agni intermediate range ballistic missile (IRBM) took place from the Interim Test Range at the Chandipur-on-Sea site in Orissa on 29 May, the first test having been carried out on 22 May 1989. The 2500 km range Agni carried a one tonne-plus payload on its successful launch but the missile later failed to carry out the final manoeuvres in the re-entry stage, owing to "premature ignition and separation of the second stage".

Russia 'Go-ahead' on Tech Transfers

Russia has refused to bow to US pressure to stop the sale of rocket engines to India and said it would honour the contract with New Delhi, inviting neutral international experts to remove doubts from any side. Asked about the US "warning" to both Russia and India that it would impose penalties in case Moscow went ahead with the sale of rocket engines to India, it was stated that the Russian approach was fully in line with the norms of international relations. Further, Russia and India had finalised the text of a new Friendship Treaty to replace the 1971 Indo-Soviet treaty and assured uninterrupted supplies of defence equipment and crude oil to New Delhi.

100th MiG-27M delivered

HAL's MiG-Complex handed over the 100th MiG-27M swing-wing fighter built by it to the Indian Air Force during a formal ceremony at Ojhar airbase (Nasik) on 2 May 1992. The first HAL-MiG-27M was delivered to the IAF on 14 December 1984 and the aircraft has been progressively manufactured with increasing indigenous content since then. HAL's MiG-complex started off in 1964 with production of the MiG-21FL, moving to the 'M' and 'bis' variants over the next twenty years.

Ajeet Trainer

The Public Accounts Committee (PAC) has criticised the Ministry of Defence for its failure to develop and produce a trainer aircraft (the Ajeet jet trainer) which has entailed a "huge infructuous expenditure" of Rs 37 crore. In its 25th report on the development and production of this aircraft, presented to the Lok Sabha the Committee asked the government to "draw suitable lessons from the sad experience from this project and take corrective steps to obviate the chances of such recurrences in the future".

Women Flight Cadets

For the first time, nine women flight cadets will enter portals of the Air Force Academy at Dundigal, on 6 July 1992. These pioneering

women had secured top ranks among a total of 275 women who were chosen after a rigorous selection process during which they underwent the same physical obstacle course and mental aptitude tests as men.

"Vayudoot still not viable"

The Controller and Auditor General of India (CAG) has cited major lapses in the planning and operations of the country's feeder airline Vayudoot since its inception, resulting in huge losses. In the 10 years of its existence, the Company had failed to make its operations financially viable. The CAG report pointed out that Vayudoot had not been given the mandate by the government to operate services in "regions other than the north-east" on considerations other than commercial. In fact, its operations in these regions were not in conformity with the government policy".

The other critical observations contained in the report are : failure to maintain schedules in respect of stations operated by it. Poor seat utilisation also has been a chronic problem. As regards the latter, the seat utilisation was below 50 per cent during 1987-88 to 1989-90 on as many as 20 to 25 routes. At least seven routes were operated below 20 per cent utilisation. The lowest was Bombay-Ratnagiri at 6.8 per cent. According to the report, the break even seat factor was above 200 percent at least in one of the years.

Su-27s For Pakistan ?

The PAF is seriously discussing the procurement of Sukhoi Su-27 long-range interceptors from the CIS, as the earlier reported intent to buy Mirage 2000s from France is unlikely to be followed through. The Mirage 2000s are considered as "too expensive" and this not "cost-effective" for the PAF while the Su-27 is being offered at substantially lower prices. Further, the Chinese PLA Air Force is to receive a batch of Su-27s and perhaps, considering the close-cooperation between the two air arms, a common new fighter type may be advantageous. According to the reports, the PAF is likely to order 60 Su-27s with a follow up for another 40 with the option to licence assemble or even manufacture the type by PAC in Pakistan.

The Euro Fighter

Germany is understood to be pulling out of the European Fighter Aircraft (EFA) project, putting the entire \$36 billion project into jeopardy. Germany has already invested \$3.6 billion in the project but is under great internal financial pressures, compounding an on-going recession and the cost of "reunification". The Eurofighter consortium, including the UK, Italy and Spain, formed in 1986, had plans to develop and build some 764 EFA but subsequent cuts by Germany, Spain and Italy had reduced this to 667. The unit cost of the EFA (being developed as a single-seat, highly agile air superiority fighter with secondary ground attack role) is estimated at nearly \$ 80 million.

Tale Spin

Hawai chappal on hawai jahaz !

"People in rubber sandals will now also fly" was the catchy refrain as an ATR took off from Jabbarhatti airstrip near Shimla for Delhi, thus symbolically inaugurating UDAN services. However, there was obviously some disconnect with the next line which read "earlier, air travel was meant only for the raja-maharaja and elite class". The ATR belonged to the Air India subsidiary which long has had the 'Maharaja' as its symbol.

Will that symbol now change ?



Fly Bikini Airlines



A Vietnamese entrepreneur who has made a fortune by staffing an airline with women in sexy bikini attire is on her way to becoming Vietnam's first female billionaire. VietJet Air CEO Nguyen Thi Phuong Thao's idea of dressing up the airline's flight attendants with sexy outfits is about to pay off big time. "You have the right to wear anything you like, either the bikini or the traditional ao dai [traditional Vietnamese clothing]," the CEO said.

That is a choice if there was one !

Oh, Ma !

First it was the 'Mother of all Wars' as late President Saddam Hussain boasted before the first Gulf War and now it is the 'Mother of all Bombs' which the USAF dropped on a target close to the Afghan-Pakistan Border in mid-April 2017.



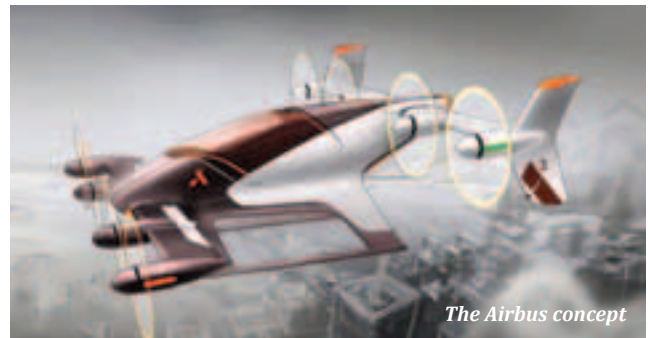
Technically, it was the GBU-43/B Massive Ordnance Air Blast bomb (MOAB) which quickly got to be associated with mothers ! The Russian response was not long in coming when they revealed their 'Father of all Bombs'.

Can we please keep the family out of this ?



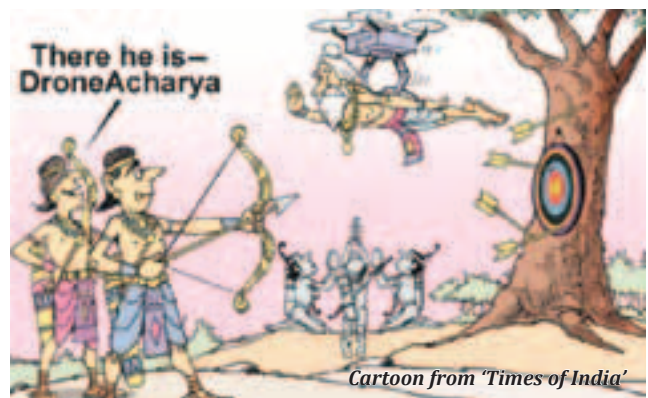
No Comment (from the Net)

Beat the traffic !



Uber's idea is certainly audacious. Thwart traffic in congested cities by flying over it. Quick, quiet, clean, cheap. This concept—which requires a new type of battery-powered vertical take-off and landing vehicle (VTOL)—is Silicon Valley to its core in terms of self-liberation and greater efficiency. These electric vehicles would operate from 'vertiports' situated around urban areas, predominantly atop buildings. And, at some point in the future, they would be unmanned. Uber disclosed the initial steps of its air-travel vision, with initial testing expected by 2020 in Dallas and Dubai.

flyDubai !



We were droning first !

Afterburner



70 mm SYSTEMS FOR TODAY AND TOMORROW

LETHAL AND AFFORDABLE

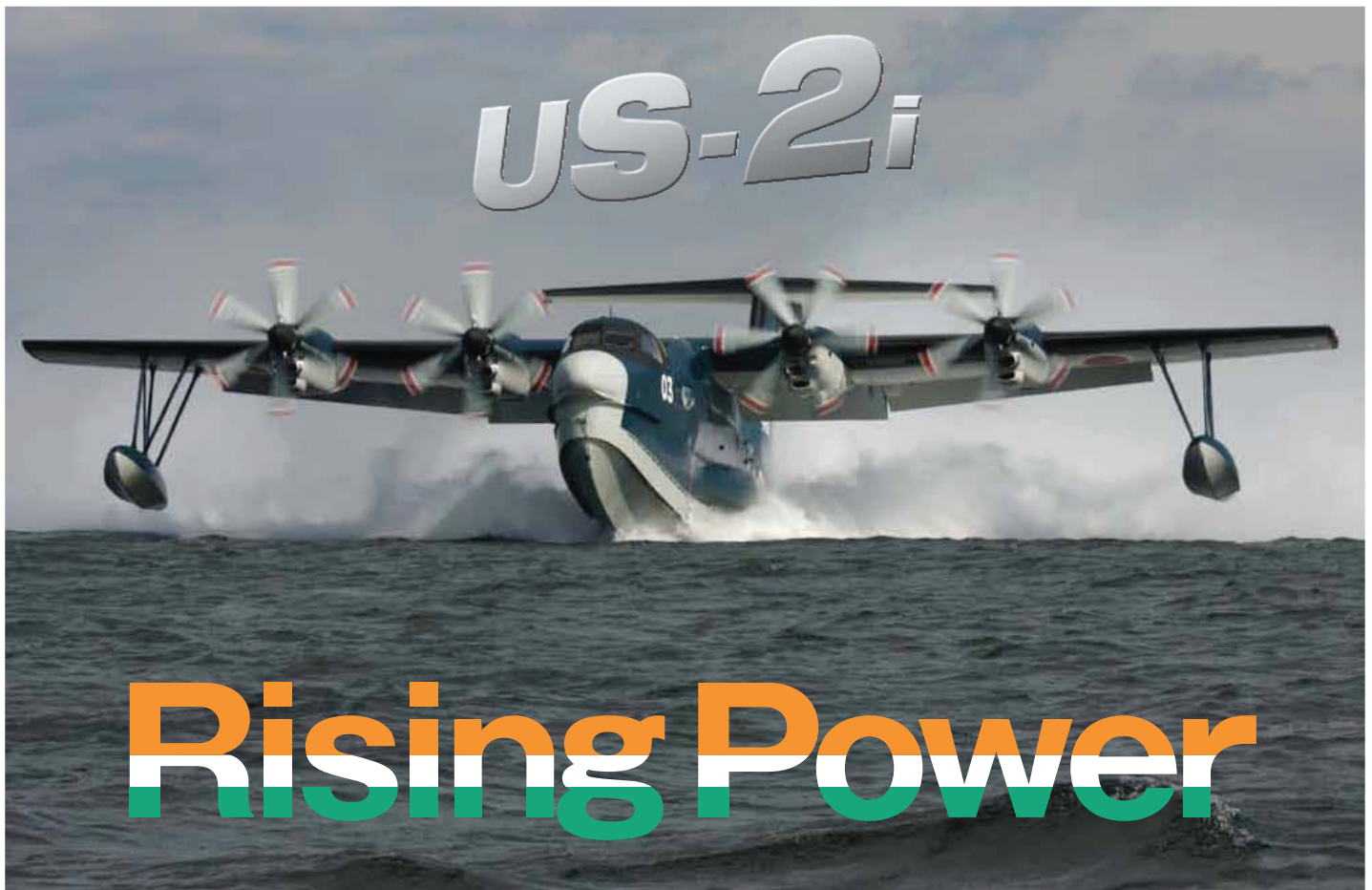


The advanced design of Nammo's 70 mm Multi-Purpose Penetrator (MPP) system is the result of sustained research and years of expertise.

Significantly improved penetration capabilities ensure the 70 mm system can face anything, from reinforced concrete bunkers to vehicles, and delayed initiation releases the blast's full effect inside your target. Designed for today's combat environment, the 70 mm system gives the enemy nowhere to hide.

Nammo

SECURING THE FUTURE



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