TECHNOLOGY SCAN

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ADVANCEMENTS IN DRONE SWARMS

1. The military forces world over are now developing and conceptualizing ***drone swarms.*** A swarm consists of multiple unmanned aerial vehicles (UAVs) with a certain amount of autonomy to navigate and sense the surrounding area. In comparison to Predators or Reapers they are smarter and more autonomous, designed to take off and land on their own, fly mission sets on their own, refuel in the air on their own, and penetrate enemy air defences on their own.

2. The use of drones in recent and ongoing conflicts in Syria, Yemen and Nagorno-Karabakh has underscored the significance and utility of mass application of unmanned and autonomous vehicles. Such swarms also force the adversary to expend munitions and other military resources, thus signalling positions in a way that enables further precise attacks or electronic countermeasures.

3. The development of Drone swarms and further advancement in this technology in various countries is covered in succeeding paragraphs.

The United States: The American Swarming Program

4. In an attempt to stay ahead of the curve, the US has been heavily investing in the research and development of drone swarms. Three developments in the US swarming programme are particularly interesting: the Perdix drone swarm, the Low-Cost UAV Swarming Technology (LOCUST) and the Control Architecture for Robotic Agent Command and Sensing, or CARACaS systems.

5. **Perdix Drone Swarm.** In October 2016, the United States Strategic Capabilities Office (SCO) launched a 103-strong swarm of Perdix drones in California. The UAVs were launched from three F/A-18 Super Hornet fighter jets showing the ability of the US Air Force to use the developments in swarm technology in combination with their advanced air superiority and “cutting edge innovation”.

6. The Perdix drone is a micro-UAV as its wingspan is less than 30 centimetres – making it ideal for operating in urban environments. It comes with two sets of wings, a small battery pack, and a built-in camera. It’s a simple design that originated in 2011 with MIT’s Lincoln Lab and was later picked up by the SCO for experimentation. The drone is packed into a small box which can be ejected from the flare dispenser on a fighter jet, an important solution because it means the systems can be mounted on existing planes with ease. The swarm demonstrated advanced behaviours ‘such as collective decision-making, adaptive formation flying, and self-healing’. It was likened to a collective organism, sharing one distributed brain for decision-making and adapting to each other like swarms in nature’.

7. The Perdix systems connected with each other and formed the swarm on its own, without need of micromanagement from operators. The swarm could also react to reform a pattern or complete a mission even if some of the systems died, meaning that one Perdix drone failing would not cause the others to abort mission. Perdix Micro-drone demonstration is shown as above.

8. **LOCUST Program**. Whereas the Perdix drones indicate a move towards autonomously functioning hardware, the LOCUST programme refers to the *software* used. LOCUST is currently being used in Coyote UAVs that are tube-launched from a platform – not dissimilar from the anti-ship missile launchers currently on board US naval vessels. Seen as a cheaper way of gaining attack capabilities the LOCUST programme could potentially substitute for a single, expensive, anti-ship missile. LOCUST systems fire a minimum of 30 Coyote UAVs in 40 seconds and they are then synchronised mid-flight to create the swarm. At around $500,000 for a 30-drone swarm and just $15,000 for a single unit, the cost of LOCUST is less than half the price of the currently deployed million-dollar Harpoon anti-ship missile. The LOCUST is specifically intended to take advantage of the low-cost UAVs such as the Coyote – the drones are expendable so that if one is destroyed 'the others autonomously change their behaviour to complete the mission' – into an offensive dimension.

9. **CARACaS Program.** Finally, the third development in the US swarming programme can be found in the CARACaS programme. CARACaS developed both software and hardware that can be fitted in any vessel in the US Navy illustrating that the move towards autonomous systems is happening across multiple theatres. CARACaS is currently used in small, unmanned boats – but can be used in any vessel – and operates using swarm technology that allows the boats to communicate with one another. The idea behind this project is that expensive but important routine tasks such as harbour patrols could be delegated to an unmanned supervised system. The Navy's CARACaS system is removing the 'dull, dirty, and dangerous tasks from sailors lives'.

10. **Gremlins Program.** The US Defense Advanced Research Projects Agency (DARPA) has also showcased the **X-61A Gremlin air launched drones**. The idea behind DARPA's Gremlins program is to turn cargo aircraft like the C-130 into motherships capable of launching and retrieving swarms of small drones, far outside of enemy defences. The Gremlins air vehicles are about 14-feet long and weigh about 1,600 pounds when fully fueled. That's much larger than Perdix micro-drones.

11. Initially demonstrating recovery of four Gremlins, in long-term, a single C-130 can recover up to 16 of such vehicles, depending on operational requirements. And conceptually, Gremlins could also be launched from F-16s, B-52s, and other aircraft with little modification to the aircraft. That could significantly alter the number of systems in a swarm.

12. This would open up a world of possibilities to the military, allowing deployment of swarms of small, inexpensive, reusable drones with different sensors and payloads from legacy aircraft.

Russia

13. The Russian military is working on developing swarms of robotic systems in the air, on the ground, and at sea andsome of these projects are close to reality.

14. As early as 2017, during the annual conference on the "robotization of the Russian Armed Forces", the robotic swarm concept was deliberated.

15. In 2018, MOD's "ERA military innovative technopolis" hosted UAV swarm trials together with the scientists from the Advanced Research Foundation—an organization similar to the United States 'Defense DARPA—and Moscow Institute of Physics and Technology.

16. That same year, Concern Radio-Electronic Technologies, a state-owned conglomerate, claimed that by 2025, it would develop a helicopter capable of controlling a swarm of drones.

17. ***In 2020, MOD also conducted its first aerial swarm trial with three different drone types*** that were used extensively in Syria, giving Russian forces layered coverage that extended up to 250 kilometers.

18. ***Staya*-93.**The MOD's Zhukovsky and Gagarin Air Academy's Scientific Research Center is currently working on the *Staya*-93 proposal—*Staya* is Russian for "flock"—concentrating on the connection and communication between the leader and follower drones, especially when drones may be subject to extensive adversary countermeasures.

19. ***Molniya.***Another recent swarm concept by the Kronshtadt Design Bureau called *Molniya* involves launching multiple jet-powered stealthy drones from manned and uncrewed platforms to conduct aerial and ground strikes and to provide electronic warfare and reconnaissance capabilities.

20. By the end of 2021, Russian military forces would acquire multifunctional long-range drones to deliver precision strikes that can act in a swarm with manned aircraft, as well as with ground and sea-based robotic systems. These drones include the ***Okhotnik* S-70** heavy combat UAV and ***Altius drones.***

21. The MOD priorities for military UAV development include ***introducing elements of artificial intelligence into the drone control systems, along with UAV swarm development.***

22. In April 2021, the MOD announced that it is working on a project to create a specialized unmanned aerial vehicle to identify and combat enemy submarines. As envisioned, these drones will be able to operate in a swarm using elements of artificial intelligence. The MOD hints that in order to accommodate the necessary equipment and weapons, a drone model with a large payload, such as the S-70 *Okhotnik* or Altius, can be used. Another proposal involves Russia's prospective long-range stealthy PAK-DA bomber launching and directing UAV swarms.

23. The Advanced Research Foundation is developing the ***Marker UGV*** as a test bed for multiple technologies, including AI and swarm control for ground and aerial robots.

24. Another UGV, the heavy ***Udar*****,** is based on a BMP-3 armored vehicle chassis and is envisioned to work with UAV and UGV formations.

25. The new ***Kungas concept*** undergoing MOD evaluation involves a group of different-sized UGVs for intelligence, surveillance, and reconnaissance, along with combat duties.

26. The MOD is also designing an ***underwater microbot swarm that can work in Arctic conditions for hours at a time***, while also working on a massive Iceberg underwater concept for Arctic exploration that will involve multiple crewed and uncrewed platforms.

27. When it comes to utilizing AI for swarms 'command and control, the Russian military establishment and its experts admit that much work remains in developing key algorithms that would be able to guide the combat robots through the uncertainty and unpredictability of a combat environment.

China

28. The Chinese are the closest in matching the high density drone swarm capability of the United States and in many ways are replicating the US R&D initiatives with development of AI empowered autonomous drone swarms. Recently The China Academy of Electronics and Information Technology (CAEIT) tested a 48 x tube launched drone swarm of CH-901 UAVs. CAEIT in the past has demonstrated a 200 unit drone military swarm in 2017. Chinese companies have also demonstrated impressive swarms of 1,000 plus drones using quad-copter-type drones for large public displays, which however are ground controlled and do not have distributed intelligence.

29. The Chinese are undertaking integration of their existing UAV fleet in a robust collaborative autonomy role with the military. It also has a loyal wingman AVIC 601-S 'Anjian 'under development, which will operate with the fourth and fifth generation PLAAF fighters platforms. China's capability and potential threats are definitely real and evolving at a fast rate. China already holds a Guinness World Record for flying 3,051 pre-programmed drones at once.

UK

30. UK may have the world's first operational swarm drone unit by the middle of 2021 to perform tasks including suicide missions inside enemy lines and

overwhelming adversary air defences. The Royal Air Force's №216 squadron has been tasked to test and deploy future drone swarm capability. The UK has also announced the Project Mosquito, which is a part of the RAF's Lightweight Affordable Novel Combat Aircraft (LANCA) unmanned loyal wingman program. This aims to fly a networked unmanned wingman by 2023.

31. UK has also tested an autonomous swarm of drones each carrying a variant of Leonardo's BriteCloud expendable active decoy as an electronic warfare payload. Using the BriteClouds, which contain electronic warfare jammers, the drones were able to launch a mock non-kinetic attack on radars acting as surrogates for a notional enemy integrated air defence network.

France

32. Airbus in France has demonstrated for the first time collaborative remote carrier (RC) swarms and wingman technology towards the Future Combat Air System (FCAS)/Systeme de Combat Arien du Futur (SCAF) program.

Other Nations

33. **Israel** is developing swarm technology, where details on such initiatives are closely guarded. Interestingly, IAI offers a **smartphone-based swarming command and control application** for worldwide sales.

34. **Turkey**, which has proven mature MALE UAV capabilities in Syria and Libya through locally made platforms like the TB-2, also has various swarm drone initiatives. Primary amongst them is the **Kargu quadcopter** which can be employed in kinetic attack roles in the tactical battlefield area. Turkey is vying to be a global UAV power in the days to come.

35. **Iran** is another middle eastern nation which has used drones in groups operationally. Iranian authorities use drones for two main purposes — surveillance and attack, where Iran has the ability to conduct missions over the horizon and in most weather conditions. These include drones with the ability to drop bombs or launch missiles and return to base and 'kamikaze 'drones that seek targets of opportunity. Iranian authorities have had more success with the latter as was visible in the Saudi oilfield strikes in 2019, where Iranian made drones and cruise missiles were allegedly used. While baseline collaborative autonomy in terms of vehicle flocking may be available, both Iran and Turkey have not shown true distributed intelligence ability amongst their UAV swarms. But their efforts are a clear indication of how the technology is maturing and proliferating.

India: Drone Swarms Development

36. The Indian Army showed off a mature offensive capability with a swarm of 75 autonomous drones with distributed intelligence and edge computing, destroying a variety of simulated targets with kamikaze attacks during India's Army Day parade in New Delhi in January 2021. In the demo, scout drones investigated the targets, then attack and mothership drones released payloads and explosive-laden kamikaze drones, which carried out the attacks. Western commentators noted several significant features of the Indian Army demonstration comparing it to the United States effort around drones, which often emphasises a large homogenous swarm. It

was pointed out that India's original work, which showcased a heterogenous swarm effort for the first time in the world in public — as the probable way forward in this domain. An Indian Start-up company NewSpace Research & Technologies is associated with the Indian Army on its swarm development program.

37. The Hindustan Aeronautics Limited (HAL) in India has unveiled the Air Launched Flexible Asset (ALFA -S) air launched swarming drone system as part of its next generation Combat Air Teaming System (CATS). This is a unique program which utilises a network of air launched remote carriers and swarming units to penetrate contested airspace. The USAF's Air Force Research Labs is collaborating on aspects of the ALFA-S with India. NewSpace Research & Technologies Pvt Ltd is also a partner in the HAL's ALFA initiative.

38. Another component of HAL's CATS program is the Warrior loyal wingman asset. This is geared for air defence and offensive strike missions and will be employed in a Manned & Unmanned Teaming (MUM-T) role with India's Tejas LCA and the upcoming AMCA fifth generation combat aircraft. What is noteworthy is that India is well driven by the power of indigenous research and the government's 'Make in India 'push to embrace disruptive technologies, which in some areas is at par with similar efforts happening across the world. HAL has unveiled the first 1:1 mock up of the Warrior in AeroIndia 2021 at Bengaluru.

39. Three Indian start-ups have won a three-year-long swarm drone competition organised by the Indian Air Force. The 'swarm architecture 'award went to New Space Research & Technologies Pvt Ltd, run by former IAF officer Sameer Joshi. Incidentally, NewSpace had recently won a USD 15 million swarm drone order from the Indian Army. The 'communication architecture 'award went to a Delhi Technology University team in a tie-up with Adani Defence, and the 'drone architecture 'award went to Dhaksha Unmanned Systems.

40. The IAF had conceptualised the Mehar Baba Swarm Drone Competition, which was launched on 3 October 2018, to encourage development of swarm drones, for utilisation in varied domains. The name of the competition honoured Late Air Commodore Mehar Singh, affectionately called 'Baba 'Mehar Singh by his associates and admirers in the IAF. It was conceptualized to evolve proprietary design, development, manufacturing and production of "low cost-high impact" solutions for swarm drone technology. The competition was open to only indigenous talent and indigenous start-ups.

Peculiarities of Drone Swarms and Future Pathway

41. The United States Strategic Capabilities Office (SCO) did not actually create the swarm; engineering students at the Massachusetts Institute of Technology (MIT) did, using an "all-commercial-components design. Thus, if drone swarming technology is accessible enough that students can develop it, global proliferation is virtually inevitable. Therefore, new drone technology is being deployed quickly by various countries.

42. **Creation of Task Allocation Algorithm**. Creating a drone swarm is fundamentally a programming problem. Drones can be easily purchased at electronics stores or just built with duct tape and plywood as the Islamic State of Iraq and Syria did. The drone swarm challenge is getting the individual units to work

together. That means developing the communication protocols so they can share information, manage conflicts between the drones, and collectively decide which drones should accomplish which task. To do so, researchers must create task allocation algorithms. These algorithms allow the swarm to assign specific tasks to specific drones. Once the algorithms are created, they can be readily shared and just need to be coded into the drones.

43. **Utilization of Artificial Intelligence (AI)**. Experts in national security and artificial intelligence debate whether a single autonomous weapon could ever be capable of adequately discriminating between civilian and military targets, let alone thousands or tens of thousands of drones. According to AI experts in the US, in certain narrow contexts, such a weapon might be able to make that distinction within 50 years. They opine that AI cannot yet manage the complexities of the battlefield.

44. **Advanced Swarm Capabilities.** Advanced swarm capabilities like heterogeneity (drones of different sizes or operating in different domains) and flexibility (the ability to easily add or subtract drones) are still quite novel. However, getting the drones to collaborate and drop bombs is achievable.

45. **Quantum of Risks Involved**. Drone swarms worsen the risks posed by a lethal autonomous weapon. Even if the risk of a well-designed, tested, and validated autonomous weapon hitting an incorrect target were just 0.1 percent that would still imply a substantial risk when multiplied across thousands of drones.

46. **Drone Communication.**Drone communication means an error in one drone may propagate across the whole swarm.

47. **Emergent behavior**. It is a term for the complex collective behavior that results from the behavior of the individual units and is a powerful advantage of swarms, allowing behaviors like self-healing in which the swarm reforms to accommodate the loss of a drone. But emergent behavior also means inaccurate information shared from each drone may lead to collective mistakes.

Future Pathway

48. Armed, fully-autonomous drone swarms are future weapons of mass destruction. Swarms could cause the same level of destruction, death, and injury as the nuclear weapons used in Nagasaki and Hiroshima—that is tens-of-thousands of deaths. This is because drone swarms combine two properties unique to traditional weapons of mass destruction: mass harm and a lack of control to ensure the weapons do not harm civilians.

49. Countries are already putting together very large groupings of drones. The US Naval Postgraduate School is also exploring the potential for swarms of one million drones operating at sea, under sea, and in the air. To hit Nagasaki levels of potential harm, a drone swarm would only need 39,000 armed drones, and perhaps fewer if the drones had explosives capable of harming multiple people.

50. Consequent to its display of 75 drone swarm on Army Day parade in New Delhi in January 2021, India has expressed the intent to scale the swarm to more than 1,000 units.

51. Drone swarms may also be useful as strategic deterrence weapons for states without nuclear weapons and as assassination weapons for terrorists.

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52. Expendable micro drones. The Perdix micro-drones are capable of low-altitude intelligence, surveillance, and reconnaissance and other short-term missions. They can be air, sea, or ground-launched and operate in both small and large swarms to perform their missions.

Source: Strategic Capabilities Office, Perdix fact sheet

53. DARPA's Gremlins program, shown in this artist's concept, envisions launching groups of unmanned aircraft from bombers, transports, and fighters to attack targets while the host aircraft are still out of range.

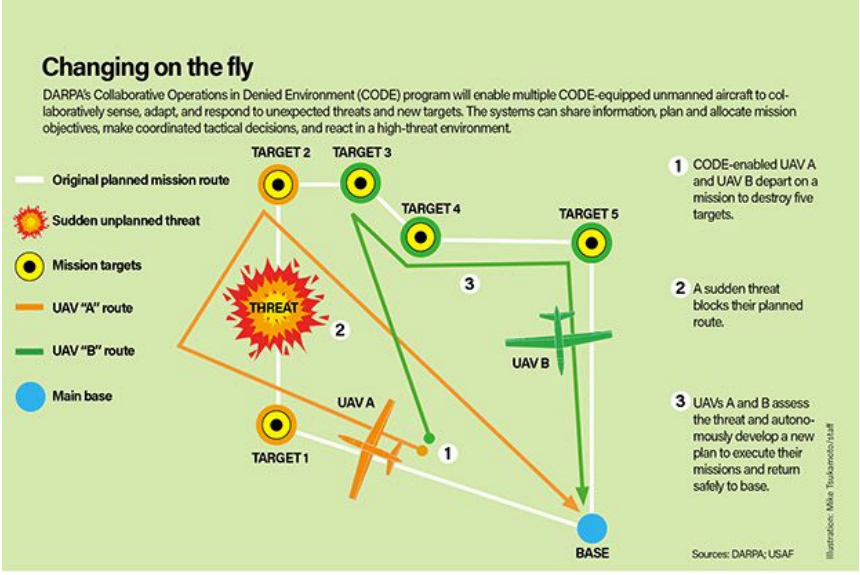

Illustration: DARPA

54. Changing on the fly. DARPA's Collaborative Operations in Denied Environment (CODE) program will enable multiple CODE-equipped unmanned aircraft to collaboratively sense, adapt, and respond to unexpected threats and new targets. The systems can share information, plan and allocate mission objectives, make coordinated tactical decisions, and react in a high-threat environment.

Source: DARPA; USAF

Russia's S-70 Okhotnik loyal wingman with a Su-57 fighter

Indian Army demonstrated a 75 drone heterogenous swarm on Army Day 2021 in New Delhi

The Turkish Army has deployed 500 plus Kargu swarming drone systems for kinetic attack

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EVALUATION OF THE BLACK EAGLE (J20's) POTENTIAL

55. J 20 is one of the two stealth fighters developed by China. The other, FC-31, a smaller twin engine multirole stealth fighter is being developed by the Shenyang Aircraft Corporation and is being marketed for the international customers. It first flew in 2012 and later a modified version in 2016 but, has been rejected by People Liberation Army Air Force (PLAAF) in favour of J 20.[1] Chengdu J-20 is a single-seat, twinjet, all-weather, stealth, fifth-generation fighter aircraft developed by China's Chengdu Aerospace Corporation for the People's Liberation Army Air Force is a multirole stealth fighter which is can carry out both offensive and defensive operation. It flew the maiden flight in Jan 2011 and entered in service in 2017-18. It has been officially endorsed by China and as per media reports it holds nearly 150 air craft in its inventory. It can fly up to the maximum speed of 2100 km, has a maximum range of 3400km and service ceiling of 18000m.[2] Its multirole

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[1]www.aninews.in/news/world/asia/chinas-j-20 fighter-turns -ten
[2]https://www.airforce-technology.com/projects/chengdu-j20/

performance, weapons and radii of action has prompted the analysts to assert that it has given China a potential to project power beyond its shores.[3] However, there remain questions on its stealth, ability to carry out sustained high speed and capacity to carry the armament load in comparison to the other operational 5th generation fighters. J 20 also faces criticism for being a copy and product of reverse engineering. Its front airframe resembles F 22 (Raptor) and the rear section with Sukhoi T 50.[4] This criticism may be unjustified as there remains not much variety in stealth air frame designs. The dual seat version under development/testing is specific to J20 since F22 /F35/ SU57 do not have dual pilot versions. Chinese two crew aircraft is meant provide better ability to exploit the enormous information from sensors and networking and also enable manned and unmanned teaming. The aircraft will perform roles for the PLAAF, it would as well be operated from the aircraft Carrier of the People Liberation Army Navy (PLAN).

56. **Characteristics of 5th Generation Aircraft.** The characteristics of 5th generation are not universally accepted but what makes a so-called "fifth-gen" fighter is a combination of:-

(a) Stealth.

(b) High maneuverability, super-cruise.

(c) Advanced avionics.

(d) Networked data fusion from sensors and avionics.

(e) Ability to assume multiple roles.

57. Most of these features are present in the J 20. As per estimate till date 150 units[5] of J 20 are manufactured and it figures prominently amongst the operational four 5thgeneration aircraft i.e. F22 and F 35 (America), SU 57(Russia). A critical evaluation of the aircraft as a 5th generation fighter with 5th generation attributes will help in impartial assessment of the aircraft potential.

58. **Stealth.** Some analysts do not agree with the stealth feature being a major qualification of fifth generation aircraft. It is contended that low radar cross-section and use of radar-absorbent surface coatings may make the radar less detectable,

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[3]https://chinapower.csis.org/china-chengdu-j-20/
[4]https://www.wionews.com/photos/in-dogfight-over-himalayas-between rafale=-vs-chinas-j-20-stealth-fighter-who-wins-326656\j-20-aircraft-blackeagle-326643
[5]www.eurasiantimes.com/chinese-j-20-miles-to-go-before-it-can-counter-us-f-35s-dominance/?amp

but these do not make it invisible. The fighter will eventually become visible on switching of its air borne radar which is something like turning on a flashlight in a dark room. The aircraft is detectable due to IR emission of the exhaust by the adversary's Infrared Scan and Track (IRST) facility. Secondly, this aircraft has a good frontal stealth feature but, not side plane and rear view. The emphasis on frontal stealth makes it an effective long-range interceptor, meant for mid-air engagements of particularly of AWACS and fuel Tankers using its BVR capability. Others opine that J-20 as a long-range strike aircraft, best suited for penetrating enemy air defenses and damaging critical infrastructure on the ground. Such high-value targets would include airfields, command bases, and other military installations.[6] How J 20 will be eventually utilized by the Chinese is a matter of speculation but undoubtedly the stealth feature is a big advantage against the Active Air Defences.

59. The stealth features while makes the aircraft less discernible to high frequency surveillance radar, is not as stealthy to the radars operating on low frequency. Therefore, defended areas must necessarily have complement of low and high frequency radars to detect stealth aircraft threats and also to tackle incidence of jamming unleashed by them. It is expected that stealth feature of J 20 will improve in the later upgrades.[7] In comparison both F22 and F-35 have lower radar cross section than J 20 in all planes of view and are therefore, more stealthy.

60. **High Maneuverability/Super-cruise.** As a principle, the combination of stealth and super cruise will yield high lethality and survivability as well as provide capacity to cover large range. The presence of a canard-delta configuration will eventually provide both efficient supersonic cruise, and good supersonic and transonic manoeuvre performance when fitted with engines of sufficient thrust rating. The high manoeuvrability/super cruise is dependent on the thrust generated by the engines. It is an open secret that J-20 with its current interim engines (Russian Al-31FN and indigenously developed WS-10C) till replaced with powerful engine can perform limited degree of super cruise. The WS10C is the modified version of WS10 which is already being used in Chinese fourth generation aircrafts J10 and J11. An upgrade with indigenous WS-15 engine is planned which will help in exploitation of its intended kinematic potential in terms of manoeuvrability and super cruise.[8] Shenyang Aero-engine Research Institute has been already manufactured WS15 engine as developed by the Xian Aero engine corporation.[9] But, air force is not happy and wants changes. PLAAF long term goal is to have engine matching the F119 engine used by the American F22 Raptor.[10] Its modification process has been delayed due to the pandemic but, the Chinese are confident that WS15 after modifications will meet the specifications allow full exploitation of the operational potential of the aircraft. The aircraft is designed with canard which allows better kinematic performance even at the higher speeds, which is positively an advantage and fits is role as an air superiority fighter.[11]

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[6]https://chinapower.csis.org/china-chengdu-j-20/
[7]http://www.ausairpower.net/APA-NOTAM-090111-1.html
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61. **Armament/Stores**. The aircraft has eight hard points and a large belly weapon bay to carry armament stores (as visible in a photo in Zhuhai Air show in 2018). Each fighter carried a one PL-10 short-range air-to-air missile in each side bay plus four long-range PL-15/PL21 missiles in the centerline bay. A staggered arrangement with six PL-15s may be possible in the future.[12] The PL-10E is roughly equivalent to the U.S. Sidewinder missile. The PL-15 is similar to the American Advanced Medium-Range Air-to-Air Missile (AMRAAM) and has the range of 200km while, PL10E is short range heat seeking missile meant for launch within visual bubble in combat. These are stored in small side-bays but, can be rotated outside prior to launch. While US F22 too has three bays but, its central bay holds six BVRs compared to four carried by J 20. By contrast US F 35 can carry two BVRs in the central Bay. Unlike US's F22 and F 35, J 20 does not carry guns which mean that aircraft will avoid close engagements. The significant benefit of using a gun is that it does not rely on the aircraft's radar system. Radar missiles must work in concert with the aircraft's radar, which are very susceptible to enemy aircraft manoeuvres and countermeasures.[13] The aircraft has not been designed to carry PL-X missile (range up to 400 km), may eventually get integrated. Carriage of PL-X would have given positive advantage in its air superiority role.[14] There are four hard points for carrying external tanks which would help extend its ferrying range but, are not likely to be used in the combat role since these will compromise the stealth of the aircraft.

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62. Precision guided ammunition comprising bombs / missiles are carried for the strike role. Development and integration of strike weapons will allow the J-20 to serve in a strike and limited maritime strike role if required, while newer air to air weapons will further enhance its primary air superiority mission[16] Presently, J20 do not carry internal guns like F22/F35/SU57. Eventually the air craft may be modified to carry internal guns.

63. Chinese believe that dogfights are not relevant with engagements taking place at beyond visual range; hence investment in guns is unnecessary. Moreover, the use of guns in highly maneuverable platforms is a challenge. But in congested and contested environments, the use of guns helps, as Americans learnt after the

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[12]https://www.thedrive.com/the-war-zone/24841/chinas-j-20-stealth-fighter-stuns-by-brandishing-full-load-of-missiles-at-zhuhai-air-show

[13]https://nationalinterest.org/blog/reboot/chinas-stealth-j-20-has-problem-it-doesnt-have-gun-179034

[14]https://thediplomat.com/2021/01/j-20-the-stealth-fighter-that-changed-pla-watching-forever/

[15]https://www.thedrive.com/the-war-zone/24841/chinas-j-20-stealth-fighter-stuns-by-brandishing-full-load-of-missiles-at-zhuhai-air-show

[16]https://thediplomat.com/2021/01/j-20-the-stealth-fighter-that-changed-pla-watching-forever/

Vietnam War. Both F22 and F35 have internal guns while Marine F35 has detachable gun pod. Enemy aircraft cannot jam the gun nor can the flares, chaff deceive it. As per the assessment of US analysts with absence of guns, J 20 most likely cannot succeed against even against F 15 air craft in combat.

64. A two pilot version of J20 is in offing. This development is based on the Chinese perception that extent of information is for beyond the capacity of single pilot to mange. [17]

65. **Advanced Avionics.** J20 has arrays of electro-optical and infrared sensors to obtain 360-degree coverage; it has the facility to fuse sensor data to form a common "picture" which it shares with friendly forces via a data-link. Such sensors could be particularly useful for detecting radar-eluding stealth aircraft.

66. Aircraft is equipped with an Active Electronically Scanned Array (AESA) radar, Electro-optical Targeting system (EOTS), Electro-optical Distributed Aperture System (EODAS), Data-link to transmit and receive digital data from other friendly platforms and drones if needed.

67. AESA radar which allows transmission and reception of array of frequencies in multiple beams is electronically steered at the target thus, allows stealth engagement and protection from jamming compared to passive electronically steered array (PESA) radar which transmits a single beam hence, suffers obvious disadvantages.

68. EODAS comprises six infrared sensors, flush mounted around the aircraft to provide 360 degree coverage for the pilot with sensor fusion combining the AESA radar signal with IR image to provide better situation awareness and supports the target detection and identification function of the EOTS.[18]

69. J-20 pilots also are equipped with helmet-mounted sights that allow them to target high-off-bore sight PL-10E heat-seeking missiles within a 90-degree angle of the plane's nose simply by *looking* at the target.[19]

70. **Engine.** J-20 still doesn't yet have the high-thrust WS-15 turbofans the PLAAF envisioned for them, and are currently using Russian AL-31FN or indigenously developed WS 10 C engines with both being deficient in performance. The WS-15 generates 23 percent more thrust than the AL-31FN, and would enable the J-20 to have sustained supersonic speeds without resorting to fuel-gulping afterburners. Thus, certain more aggressive projections of J-20 performance, such as a top speed of Mach 2.5, may be premised on engines that have yet to be fully developed. Chinese designers have also expressed interest in incorporating vector-thrust engines in the J-20. These have moving exhaust nozzles to assist in pulling off tight manoeuvres.[20]

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[17]www.buisnessinsider.com.au
[18]www.aviationtoday.com/2008/08/01/industry-scan-59/
[19]https://nationalinterest.org/blog/reboot/just-how-dangerous-and-how-stealthy-chinas-j-20-plane-179964
[20]https://nationalinterest.org/blog/reboot/just-how-dangerous-and-how-stealthy-chinas-j-20-plane-179964

71. **Roles.** On a larger level, the J-20 works as an Anti access/Area denial (A2/AD) weapon, which aims to deny an opposing, force the ability to operate in vicinity of the Chinese mainland—far enough that many of the enemy's offensive military capabilities are automatically nullified. But executing long-range combat air patrols or stalking an enemy's vulnerable force multiplier assets are not the only ways such an aircraft could be put to use.[21] Possible secondary roles include air-to-ground, air-to-surface and suppression/destruction of enemy air defences. In addition, the J-20's advanced avionics can be leveraged to benefit lesser platforms within the air-to-air realm.

72. **Radii of Action.** J-20's range is expected to be between 1,200 and 2,700 kilometers. Regardless of this, the J-20's combat radius is likely to extend well-beyond the Chinese mainland. As per the global times report of November 14, 2018, the J-20 is now capable of aerial refueling, this could thus even extend its operational range across the Indo-Pacific.

73. **Strategic Impact of J 20.** Most Air defence weapon systems, land based, ship-based radars and AWACS/AEWs predominately operate in X, S and L bands. These are heavily constrained against stealth air threats both in terms of acquisition by radar, guidance of missiles and kinetic intercept by aircraft or missile. Compared these, the low frequency radars in V/UHF while would give better performance and could detect stealth threats but at the cost some precision hence, not employed with the weapon radars and are primarily used for an early warning. Hence Active Air Defences should use U/VHF radars along with other detection radars to detect the stealth threats like J20 aircraft.

74. The West in particular has focused on high frequency based theatre ballistic missile defences which are heavily constrained against J 20. Russian on the other hand has developed low frequency detection system which would continue to detect stealth threats. Chinese have followed the Russian example and lay stress on the low frequency radars.

75. In strategic terms, J-20 will present a challenge to nearly all of the Integrated Air Defence Systems (IADS), air defence fighter fleets and weapons inventories deployed and operated by the United States and Asian countries, in any conflict involving China.[22]

76. The aircraft's size makes it a natural candidate for "lateral evolution" into other roles. J20 thus could be employed for range of roles namely Long Range Interceptor, air combat and escort role, theatre strike fighter using guided munitions, long-range theatre reconnaissance, as well as an electronic attack platform and even to launch air launched anti-satellite missile just as USAF used in 1980's to hit a satellite in LEO. In any conflict involving China, a well sized fleet of mature production J-20 would have significant freedom of action to attack and destroy aerial and surface targets throughout the geography up to the Second Island Chain. Thus may carry forward their agenda to exercise control till the second region.[23]

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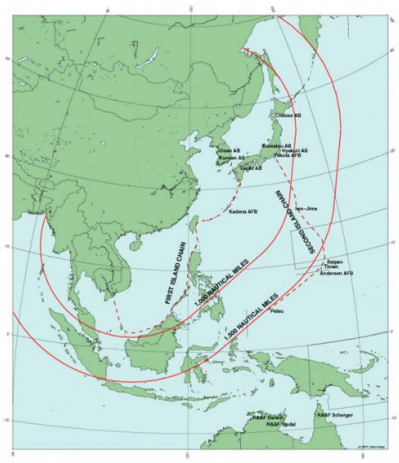
[21]https://www.thedrive.com/the-war-zone/7806/chinas-j-20-stealth-fighter-photographed-toting-massive-external-fuel-tanks
[22]http://www.ausairpower.net/APA-NOTAM-090111-1.html
[23]Ibid



[24]

77. **Comparison with Contemporary Stealth Aircraft and AMCA.** As on date, there are four 5th generation operational jets in the world. Two of these F22 and F35 belong to the United States and others one each J20 and SU 57 are from China and Russia respectively**.** Comparison between these jets is inconsequential as these have been developed with different objectives and speciality in mind but, cursory focus on few collective features which define the generation of the aircraft including stealth and data fusion capabilities can be considered. In that, America's F22 is best in the category which J20 may match once planned more powerful engine WS15 is provided. F35, a joint strike fighter, though has less combat range, is an incredible sneaky flying computer range which can make other platforms more lethal. SU 57 is least stealthy but with thrust vectoring, is able to do tighter turns hence, versatile in manoeuvrability at higher speeds. J20B, a twin pilot version of J20 under development may also have thrust vectoring which will enhance its performance.[25]

78. **F22 (Raptor) V/S J20 (Black Eagle).** In US assessment, J 20 is no match to F22 or F 35. F22 (Raptor) has better stealth attribute, ability of sustained super-cruise and carries more ordnance than J20. F22 can carry 6xAIM120 AMRAM or 2xAIM120 AMRAM + two 1000lbs Joint Direct Attack Munitions (JDAM) in the central bay and two AIM9M or AIM9X sidewinder all aspect short range air to air missiles in the side bays. F22 can also carry 4xNon-stealth Aim9 side winders or two 600 gallons external fuel tanks on external hard points but, these naturally compromise the stealth characteristics of the aircraft. Stealth pods are being developed for stealthy carriage of ordnance.[26,27] F22 is also more manoeuvrable with its streamlined fuselage than J20 which has larger air frame. Besides, it also carries 20mm Guns which enhances its lethality in close combat. In comparison J20 can carry 4x PL12C/D and PL 21 AAM BVRs in the central bay with 2 x PL10 short range air to air missiles in the side bays. It has four hard external points for carrying fuel pods during ferry and has no guns. F22 ability of sustained super-cruise without using after burners enables raptor to pursue longer and more attack missions without having to return to refuel. However, this advantage would not be available once J 20 engine WS10C is replaced with more powerful WS15 which is already claimed to be developed and will provide J20 too with capability of super cruise matching F22. While not much is known about J20 avionics but, it is expected that it is provided

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[24]http://www.ausairpower.net/APA-NOTAM-090111-1.html
[25]www.buisnessinsider.com/russia-su57canot compete- us- chinese-5th-gen-fighetr-jets-2021-6?IR=T
[26]www.airforce-technolgy.com/projects/f22a-raptor/
[27]www.militaryfactory.com/aircraft/compare-aircraft

matching types of avionics whose performances are not known. US experts are sceptical of the J20 performance. It is believed that weapon integration, sensor range, electronic warfare and targeting are F22 positive attributes. It estimated that it will outperform J20 in air to air engagement, out manoeuvre, and achieve better targeting with superior sensor fidelity.[28]

79. **J20 V/S F35 Lightening II**. F 35 was developed to replace United State's most fighter jets variants, is a single engine stealth air superiority fighter with ground attack capability and unlike F22, was developed in cooperation with several foreign partners and is intended for exports. It is much smaller in size has lesser speed (max1.6 mach compared to 2.1 mach of J 20) lesser range and operational ceiling but, it can carry large variety of armament including nuclear bombs for various roles, not much is known about the J20 except its standard armament as viewed from photographs, it positively less stealthy than both F22 and F35. Though, Chinese aircraft is equipped with comparable avionics but, American believes that these are very basic. American aircraft have pilot friendly cockpit displays that can indicate to the pilot various angles and ranges from which their aircraft can be detected by various enemy radars. Former US Air force chief Gen, David Goldfien commenting on J 20 performance told the media reporter, "Comparison between J20 and F35 is irrelevant. We apply 5th generation technology. It is no longer about the platforms but, about the family of systems. It is about networks that gives asymmetric advantage. The focus is on family of system approach where sharing of data is the key instead of fixating on the performance of individual platforms".[29]

80. **J20 and SU 57.** Just like J 20, not much is known about the Russian SU57 5th generation aircraft. However, Knowing Russian experience in aircraft designing, SU57 is expected to be better as air superiority fighter and as a ground attack platform which assisted by stealth design is meant to penetrate sophisticated air defences undetected and attack adversary's critical infrastructure and military assets. Like J 20, SU 57 is planning to upgrade its current AL41F1 engine with more powerful Saturnizdeliye 30 engines for better kinematic performance including supersonic cruise and manoeuvrability roughly at par with Raptor.[30] Russian fighter is assessed as less stealthy than its peers.

81. **J20 and Futuristic Advanced Medium Combat Aircraft (AMCA).** It is probably too early to compare operational J20 with futuristic AMCA which is still at the development stage. As per the recent media reports, its design has been frozen and development on air craft has commenced .AMCA will be single seat twin stealth all weather multirole fighter aircraft, The multirole design will cater for air superiority, ground attack, bombing , strike and other roles. The first flight is expected in year 2024-25 with an aim to start production from 2028 onwards. Supporting Indigenous development, Former air chief has told that air force strongly supports the development of fifth generation aircraft which even will have sixth generation characteristics.[31]

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[28]www.cnn,com

[29]https://nationalinterest.org/blog/repboot/stealth-fighter-death-dance-chinas-j-2--vs-f-35-stealth fighter- who- dies

[30]https://eurasiantimes.com-su-57-or- -j-20- who- will- emerge –winner- between- the- Russian-super-maneuverable- su-57-or- chinas- mighty- -j-20?

[31]www,economic times .indiatimes.com/news/defence

Will J20Pose any Major Threat to India?

82. Rafale, the newer aircraft in IAF inventory is a versatile aircraft. Rafale is 4.5 generation and lacks stealth characteristics but, in performance it is more than match to J20. While J20 can carry one mission at a time, Rafale in comparison can carry out several roles in a single sortie. However, armed with powerful sensors long range missiles, J20 could pose a serious threat to air refuelling, Airborne Early Warning Aircraft and critical support infrastructure. For this, J20 would rely on its BVR capabilities. J 20 design provides good high speed manoeuvring but, in absence of guns it will avoid air combat with even with fourth generation aircraft like Rafale which has led operations in Afghanistan, Iraq and Syria encompassing different terrain which gives it edge over J 20 which is largely untested. Rafale has 12 hard points and carry ordnance 1.5 times than weight. Which means it can carry weapons and fuel more than J20. It can carry Meteor, a BVR missile with range of 150 km and Scalp a long range cruise missile with a range of 200km. In present power configuration, J20 cannot super-cruise while Rafale can give sustained super-cruise with four missiles and underbelly fuel drop tank.[32] India's acquisition of Rafale has caused concerns with the Chinese. This is evident with their organisation of its Air Defences. Once, J20's WS10C engines are replaced with WS15engines, it is claimed that J20 would be able to fly at sustained super-cruise speeds. Assisted with stealth design J20 probably will be employed for high speed ingress to target AWACS, Refuelling aircraft and critical defence and civil assets with BVR/ARM/precision weapons. S400 deployment at suitable locations will plug J20's advantage.[33] In our defence calculations J20 long range, high speed approaches and its widespread dispersion at some well hardened deep underground locations in Tibet must be considered along with strategy to bypass/ neutralize Chinese dense air defences.

Conclusion

83. There are four 5th generation operational jets in the world and many more under development such as India, Turkey, Korea and Indonesia. Indian 5th generation aircraft's (AMCA) prototype is likely to roll out by 2024 with serial production by 2028. Hopefully, it will fill in capability gap with the Chinese J20 which is already operational and China has sizeable strength. J 20 is still underpowered and incapable of sustained high speed which is a vital performance parameter of 5th generation aircraft. Amongst the present list of four 5th generation aircraft the analysts rate F22 is the best. J20 aircraft would probably attain near comparative performance with F22 after replacement with more powerful engines which as reports is already developed and awaiting some modifications.

84. F35 Lightening II though single engine with lower speeds and lower ceiling is truly a multirole and versatile air superiority/attack aircraft. Unlike J20, It can carry large variety of armament including nuclear bombs for various roles. On the other hand, SU 57 is least stealthy but, versatile in manoeuvrability at higher speeds. A point for consideration is while other aircraft have been tested including SU57 which was deployed at Syria, J20 is still untested and much of the information is deducted from the aircraft photographs, air shows and state media leaks much of which is not reliable.

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[32]https://defenceview.in/which-fighter= can supercruise-there-are- only- four/

[33]https://www.himdustantimes.com/india-news/iaf-saysitcan tackle- chinese-j-20=stealth- jets-with- s-400-missile/

Air Cmde T Chand (Retd)

VIRTUAL REALITY CAPABILITY DEVELOPMENTS IN CHINA.

85. The hardware and software Virtual Reality capability developments of certain key players around the world are driving growth of the digital reality market at a rapid rate. The hardware market is relatively captured by larger organisations, such as Facebook with Oculus and HTC with Vive. The software market is also led by big players, such as Apple with ARKit, which was launched in competition with Google's ARCore. Alongside these prominent names, a booming ecosystem of start-ups is making a mark in the digital reality space.

86. VR has been used extensively in the entertainment industry and simulation. It has also many possible applications spanning various economic sectors, with relevance to public and national security interests such as Remote-Aircraft Maintenance collaboration through experts; Vehicular repair and maintenance in the battlefield; Tele-robotic and tele-presence in undersea activities and Digital twin of navy ships and engines. Tactical augmented reality (TAR) applications to improve situational awareness include law-enforcement training, empathy training, military situation awareness, health treatment, data analysis, counterterrorism , travel, and cultural awareness in addition to entertainment. Besides, augmented reality can provide helmet-mounted AR display, and Synthetic Training Environment (STE) in warfare. US has been leading the world in the development of reality technologies until recently.

87. China has intensified its efforts to match or even surpass US in the reality technology development efforts. It is developing two VR Towns, also known as VR Cities. Each VR town will employ various VR applications such as medical, education, business, design, and entertainment fields. Also, the town have planned to have industrial parks that will help facilitate different aspects of the VR supply chain[34]. The structure of China's government provides its executive a unique ability to select technologies as focal points and quickly mobilize relevant sectors of the economy. China has already facilitated two public-private strategic industry partnerships to organize the industry, and it has ensured VR's inclusion in notable policy initiatives such as Made in China 2025 and the 13th Five-Year Plan[35].

88. The ongoing development of 5G ICTs will have positive impacts on the VR and AR sectors, especially in education, healthcare, entertainment and telecommuting. The compound annual growth rate of China's VR and AR market over the next five years is expected to be 67.5 percent, but it will take some time to be widely accepted by the public[36].Chinese tech giant ByteDance, the owner of popular short video-sharing app TikTok, made its first foray into VR by acquiring

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[34]William Shumate and Tim Marler, Reality Check: China Is Paving a Path Toward the Virtual Future, 22 August 2021. The national Interest. https://nationalinterest.org/feature/reality-check-china-paving-path-toward-virtual-future-192127,05 November 2021.

[35] ibid

[36] FAN FEIFEI, VR, AR to boom on metaverse, the new frontier, 02 Sep 2021. The China Daily. http://www.chinadaily.com.cn/a/202109/02/WS61302575a310efa1bd66cc2c.html, 05 November 2021.

Pico, a Chinese VR headset maker[37]. Founded in 2015, Pico emerged as the world's third-largest VR headset maker in the first quarter of2020, followed by Facebook's Oculus and Chinese company DPVR, according to global market consultancy IDC.IDC also predicted that, global VR products will grow at the compound growth rate at about 48 percent up to 2024. In 2025, global AR equipment shipments will reach 24.4 million units[38].

(A visitor tries Pico's VR device during an expo in Qingdao, Shandong province. Photo by Wang Haibinfor China Daily)

89. Besides, augmented reality has three major applications namely Tactical Augmented Reality (TAR), helmet-mounted AR display, and Synthetic Training Environment (STE) in warfare.

90. VR training and AR training both have a plethora of use cases for military training in the Army, Navy and Air Force that enhance the quality of personnel training and increase their chances of carrying out successful missions. Some of the uses of VR and AR likely to be exploited more effectively by the PLA Branches are: Electronic Warfare training; Firearm Training; Sniper Training; Armoured Vehicle Simulator; Vehicle Repair and Maintenance in the Battlefield; Situational Awareness and Experience; Maintenance Repair and Overhaul Training; Medical Training; Flight Simulation; Virtual Ship Bridge and Virtual Submarine Simulator. China's state-owned *Global Times* has already reported quoting defense experts that The People's Liberation Army (PLA) has started to use virtual reality (VR) technologies in training as it allows officers and soldiers to gain enhanced combat capability more efficiently[39].

91. With more than a hundred AR/VR start-ups set up in the past three years, the AR/VR market in India is also expected to register a compounded annual growth rate of more than 50 percent in the next five years according to a Deloitte Survey. Presently, despite progress in the adoption of VR-based products, such as head-mounted display among end-users, the VR market in India is seeing a slow

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[37] ibid

[38] ibid

[39]Mansij Asthana, China Turns To Virtual Reality (VR) Technology To Hone Combat Skills Of Its Soldiers, 24 march 2021. The Eurasian Times. https://eurasiantimes.com/china-turns-to-virtual-reality-vr-technology-to-hone-combat-skills-of-its-soldiers/, 05 November 2021.

response. Organisations are only in the early stages of AR and VR adoption. Many start-ups are working on solutions for industries, such as real estate, hospitality, gaming, and retail. Start-ups like 'Digital Agents Interactive Private Limited', has been involved in collaborating with the defence forces. Founder Mohit Ramani, while speaking to Deloitte, articulated how he had a clear view of the problem statement he was looking to solve, and developed defence-specific solutions that have been successfully deployed by various departments. Another Start-up 'Staqu Technologies', through AI-and AR-based solutions, has been aiding government authorities to address security and defence related issues over the past few years through applications such as smart glasses equipped with zoom features and facial recognition, to combat terror situations in crowded settings.

92. AR is effective for warfare simulations, military sand tables, battlefield visualisations, and other applications that place a high premium on the realistic representation of defence activities[40].The use of AR in defence can also take the form of smart glasses and displays that present information regarding spatial orientation, situational awareness, weapons targeting, digital terrain, and other critical data, to mitigate lapses in safety, speed, and coordination. Devices can also allow soldiers to familiarise themselves with features such as night vision, thermal sensing, and applications that measure vital signs during training[41].

93. Smart helmets are an example of VR applications in the field. Many other use cases for the defence forces are: Remote collaboration through experts, Tele-robotic and tele-presence, Vehicular repair and maintenance in the battlefield, Digital twin of navy ships and engines, Tactical augmented reality (TAR) to improve situational awareness with night vision for soldiers, Immersive training, Situational awareness based training, Multi-user war planning systems, VR-enabled process assessment and Medical training and on-ground emergency support[42]. Indian Defence Forces are already making use of simulators in a big way and are expected to adopt emerging VR, AR and ER capabilities in due course.

Gp Capt P Bhalla

AERIAL VEHICLES

94. **FC-31 Carrier Capable Aircraft**. On 29 October, images emerged on Chinese social media platforms showing what appears to be a prototype of the Shenyang Aircraft Corporation's (SAC's) next-generation, carrier-capable multirole fighter aircraft performing its maiden flight. The images show a green-painted prototype in flight, with its landing gear extended, accompanied by a J-16 fighter aircraft. The aircraft appears to share some design commonality with the FC-31 low-observable multirole fighter prototype. Both single-seat aircraft feature two engines, twin canted tail fins, and a high-mounted cockpit. This prototype appears to have a launch bar on the front of its landing gear, allowing for catapult launches, as also a wing-fold mechanism, confirming it's intended for carrier operations. Other changes over previous versions of the J-31/FC-31 include the addition of what appears to be

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[40]Virtual, augmented, and mixed reality for defence and the public sector,https://www2.deloitte.com/content/dam/Deloitte/in/Documents/about-deloitte/in-about-deloitte-Digital%20Reality%20in%20Defence_Final%20print.pdf, 18 November 2021.

[41] ibid

[42] ibid

an electro-optical targeting system (EOTS) under the aircraft's chin. The cockpit has also been changed, with the bubble canopy of the previous FC-31 replaced with one that is flush with the fuselage and the forward section of the aircraft broadly resembles that of the Lockheed Martin F-35. The designation of the new carrier fighter remains unknown, but there has been speculation in the past that it could be designated J-21 or J-35. The aircraft's power plant is also not clear. The original J-31 was powered by the Klimov RD-93, but it is possible that the new FC-31 variant could be powered by a pair of Guizhou WS-13s. However, even after nearly a decade of testing and evolution of its land-based progenitor, the aircraft is still some time away from reaching operational status. This aircraft is expected to compliment Shenyang J-15, the current carrier launched fighter of PLAN.

95. **KJ-600 Carrier-Capable Airborne Early Warning (AEW) Aircraft.** Analysis of commercial satellite imagery captured on 2 October indicates that China is advancing the development of the KJ-600 carrier-capable airborne early warning (AEW) aircraft. The aircraft has been seen undergoing flight tests. They are expected to operate from Type-003 Aircraft Carriers that is expected to be equipped with CATOBAR (catapult assisted take-off but arrested recovery).

96. **WJ-700 UAV**. Images of a new indigenously developed (by the state-owned CASIC) Chinese medium/high-altitude long endurance (MALE/HALE) UAV has been circulating in Chinese social media from mid-August. Its first flight was conducted in January and its ability to work with other drones has been highlighted on state television. Specifications released by CASIC in 2018 stated that the turbojet-powered WJ-700 has a maximum take-off weight (MTOW) of 3,500 kg and a stated endurance of up to 20 hours. The WJ-700 adopts a conventional monoplane design with an aerodynamically streamlined fuselage measuring about 9-10 m long that supports a retractable tricycle undercarriage.

97. **FK-2000 Self-Propelled Air-Defence System**. China Aerospace Science and Industry Corporation (CASIC), a Chinese state-owned enterprise that is the largest producer of Chinese missile systems, unveiled its FK-2000 self-propelled air-defence system during the Air show China 2021 exhibition held from 28 September to 3 October in Zhuhai.FK-2000 short-range surface-to-air missile (SAM) system appears to have been derived from Russia's Pantsir family. As per the details provided, the system is capable of engaging aircraft at ranges from 1.2 km to 25 km, and at altitudes ranging from 15 m to 12 km. It is also capable of engaging precision-guided munition (PGM) targets, such as air-to-surface weapons or cruise missiles, at ranges from 1.2 km to 10 km, and at altitudes from 15 m to 8 km.