India

Money, Military & Markets-XXI

Lack of jet engines: enter drones and SAMs

- India faces a critical bottleneck in jet engine technology, delaying indigenous fighter programs like Tejas Mk-II and AMCA.
- To offset the falling squadron strength, India must invest in dense, layered air-defence networks and offensive alternatives such as drones.
- This creates a US$25bn play in saturated air-defence systems & a multi-billion-dollar drone market. BEL, BDL, HAL, ideaForge, & Solar Industries to benefit.

India faces a critical bottleneck in terms of jet engine technology

India faces a critical bottleneck in jet engine technology (especially for high-thrust combat aircraft), which directly affects fighter fleet expansion and indigenous programs like AMCA and Tejas Mk2. India relies heavily on imported GE-404 engines, while Tejas Mk1A and Tejas Mk2 depend on GE-414 engines. Given the policy vagaries of US President Donald Trump and his tendency to announce strategic deals on Twitter/Truth Social, it would be foolhardy to assume that all engines will arrive on time. Hence, assuming that Hindustan Aeronautics (HAL) will be able to deliver Tejas on schedule would be unrealistic. Therefore, India must find alternative ways to address the declining squadron numbers. Remember, Tejas is primarily used as an interceptor; its role can largely be fulfilled by an extremely dense and layered air defence network. The delay in Tejas Mk2 will also mean India will have to rely on surface-to-surface missiles in large numbers and possibly employ the S-400 in offensive roles. Currently, 272 Su-30MKI and 36 Rafale aircraft, armed with BrahMos and SCALP respectively, provide formidable precision strike capability. At the same time, the hypersonic BrahMos is under development. If India acquires fifth-generation F-35 fighters, they can operate as a separate strike entity with their own weapon systems.

Saturation air defence = investment of US$25bn over a decade

With indigenous jet engines at least a decade away and the procurement of new aircraft delayed due to bureaucratic hurdles, India's most viable option is to rapidly acquire locally developed defence systems. India has successfully developed multiple high-quality missile and radar platforms that can be procured domestically at an accelerated pace. Given the dwindling squadron strength, this approach remains the most practical way for India to maintain aerial superiority over Pakistan and simultaneously prepare for a two-front war scenario. This situation presents an estimated **US$25bn opportunity** for the domestic defence industry, distributed as follows: **Akash and adjunct systems:** ~US$6bn . **MRSAM systems:** ~US$9bn, and **QRSAM systems:** ~US$9–10bn. Please note that the above estimates assume a two-front war scenario and account for the shortage of interceptor aircraft. Additionally, a 50% discount has been applied to saturation air-defence requirements under a simplified linear assumption.

UCAVs to boost firepower amid declining squadron strength

Surface-to-air missiles (SAMs) are purely defensive and cannot project power into enemy territory. To address the shortfall caused by the declining number of attack aircraft, drones become essential. Unmanned combat aerial vehicles (UCAVs) and loitering munitions can strike deep inside enemy lines at lower risk and cost compared to manned platforms. This combination—SAMs for air defence and drones for offensive operations—creates a balanced, networked capability that compensates for the delay in procuring new fighter jets. For perspective, one Rafale aircraft (with weapons) costs approximately Rs20bn. With the same amount, India could procure: **Nagastra-1:** 1,60,000 units, **Nagastra-2:** 80,000 units, **Sky Striker:** 50,000 units, and **Harop (imported):** 2,500 units. Drone swarms enable saturation attacks by overwhelming enemy air defences. In theory, a simultaneous launch of 100,000 drones could saturate any air defence network globally, regardless of sophistication. While India currently lacks the capability to deploy swarms at this scale, it is technically feasible to field operational swarms of 200–1,000 drones, which can still impose significant pressure on enemy radar, missile systems, and command networks.

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Lack of jet engines – enter drones and SAMs

India faces a critical bottleneck in jet engine technology (especially for high-thrust combat aircraft), which directly affects fighter fleet expansion and indigenous programs like AMCA and Tejas Mk2. But there are strategies to turn the tables without waiting 10+ years for an indigenous jet engine. We need to exploit what we already excel at i.e., missiles & SAM systems: India leads in Akash, MRSAM, Barak-8, S-400 imports, and developing XR-SAM. A dense Integrated Air Defence System (IADS) can deny enemy air superiority even if our fighter numbers are low. Drone Swarms & Loitering Munitions: Use Nagastra, ALFA-S, and Ghatak UCAV concepts aggressively. Convert cheap trainer platforms (like HTT-40) into armed light attack aircraft or unmanned missile carriers. Shift to Stand-off Weapons- Cruise Missiles (Nirbhay, BrahMos) + Smart Anti-Airfield Weapons (SAAW) → can hit enemy bases without risking fighter jets. Mass-produce hypersonic glide weapons and loitering drones for deep strike roles. Force Multipliers Instead of More Jets - AWACS + Network-Centric Warfare: Use indigenous Netra Mk2 AWACS + satellite-based ISR to extend the reach of our limited fighters. Electronic Warfare & Decoys: Develop MALD-type decoys and EW pods to degrade enemy radar and SAMs. Autonomous Wingmen: Like the US 'Loyal Wingman' concept—India's CATS Warrior is on the right track. One Su-30 with 4-5 UCAV wingmen can perform like an entire squadron. Massive Drone & AI Push - Replace some fighter roles with autonomous systems, Kamikaze drones for SEAD (Suppression of Enemy Air Defences). Artificial intelligence or AI-driven swarm attacks to overwhelm high-value enemy targets. Production must be fast, modular, and scalable.

The evolution of air forces has focused on delivering weapons deep inside enemy territory swiftly and with minimal losses ➤

The core mission of the air force has always been to deliver weapons deep into enemy territory swiftly and with minimal losses. From strategic bombing campaigns in World War II to precision strikes using stealth aircraft, the emphasis has consistently been on speed, reach, and survivability. Achieving air superiority provides freedom of action for ground and naval forces, making it a decisive factor in modern warfare. Airpower evolved significantly after the slow and grinding trench warfare of World War I, which spurred numerous innovations. While the tank was one such breakthrough, the ability to strike from above and support rapid infantry movement across vast areas made air power indispensable during World War II.

Initial propeller-driven aircraft were upgraded to jet engines, as speed was essential to win aerial duels with the enemy ➤

During the Second World War, when both attacking and defending air forces relied on aircraft-mounted guns as their primary warfighting tools, speed became essential for survival. The need to outrun enemy fighters and evade ground fire led to the invention of jet engines. The introduction of radar further amplified this requirement, as German propeller-driven aircraft became easy targets for anti-aircraft guns. At that time, air-to-air and air-to-ground missiles were not yet fully developed, so aircraft depended on unguided bombs and onboard cannons to neutralize ground defences. This made speed not only critical for survival but also a decisive factor in gaining an edge over the enemy.

In the pre-satellite age and during the Cold War, reconnaissance became the key requirement for military planners ➤

In the pre-satellite era and throughout the Cold War, reconnaissance became a critical requirement for military planners. Accurate intelligence on enemy troop movements, infrastructure, and capabilities was essential for strategic and tactical decision-making, driving the development of high-altitude reconnaissance aircraft such as the U-2 and SR-71 Blackbird.

By that time, the world had developed surface-to-air missiles (SAMs), making stealth a critical requirement for survival and mission success

As aviation entered the Cold War era, reconnaissance emerged as a critical capability. In the pre-satellite age, accurate intelligence on enemy movements and capabilities drove the development of high-altitude reconnaissance aircraft such as the U-2 and SR-71 Blackbird. At the same time, advancements in air defence technology introduced a new threat: surface-to-air missiles (SAMs). With SAMs capable of engaging high-speed aircraft at long ranges, speed alone was no longer sufficient. This ushered in a new priority—stealth. Avoiding detection became as important as outrunning the enemy, leading to revolutionary designs like the F-117 Nighthawk and B-2 Spirit, which combined low radar visibility with precision strike capability.

All about jet engines and how they helped aircraft become faster

Jet engines revolutionized aviation by replacing piston engines and propellers with a more efficient propulsion system, enabling aircraft to achieve much higher speeds, climb rates, and altitudes. Here's a detailed breakdown:

What is a jet engine?

A jet engine is a type of reaction engine that generates thrust by expelling a high-speed jet of gas backward, based on **Newton's Third Law of Motion**. Unlike piston engines that drive a propeller, jet engines compress and ignite air mixed with fuel, creating powerful exhaust gases for thrust.

Main components of a jet engine

- **Intake:** Draws in air at high speed.
- **Compressor:** Compresses the air, raising its pressure and temperature.
- **Combustion chamber:** Fuel is injected and ignited, producing high-energy gases.
- **Turbine:** Extracts energy from the hot gases to power the compressor.
- **Nozzle:** Expels gases at a high speed to produce thrust.

Why jet engines made aircraft faster

- **Continuous power delivery:** Unlike piston engines, which have intermittent power strokes, jet engines provide continuous thrust.
- **High thrust-to-weight ratio:** Allows faster acceleration and higher speeds.
- **Better performance at high altitudes:** Jet engines maintain power where piston engines lose efficiency.
- **Reduced drag from propellers:** Eliminating large propeller blades removes drag limitations, allowing sleek aerodynamic designs.
- **Afterburners:** In military aircraft, afterburners inject extra fuel into exhaust, dramatically increasing thrust and speed (used for supersonic flight).

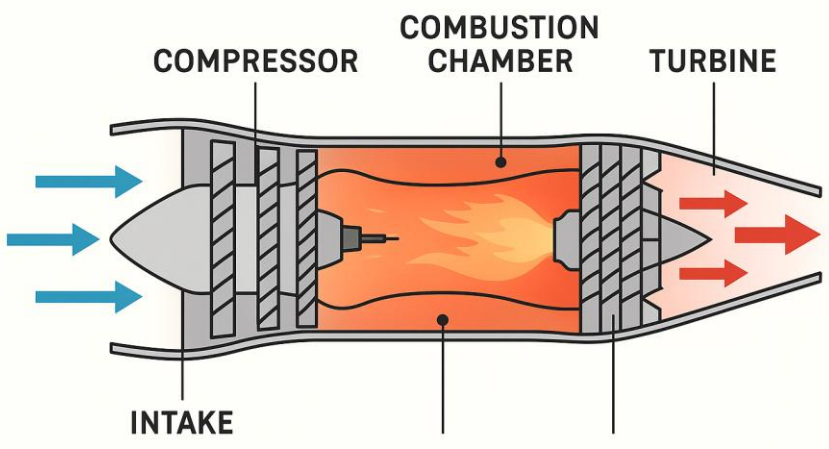
Speed evolution after jet engines

- **World War II era:** First jet fighters (Messerschmitt Me 262, Gloster Meteor) reached ~800km/h (vs. 600km/h for piston fighters).
- **Post-war:** Swept wing and jet bombers exceeded 1,000km/h.
- **Supersonic era:** Jets like the F-86 Sabre, MiG-15, and later F-104 Starfighter broke the sound barrier (>1,200km/h).
- **Modern jets:** Commercial (Mach 0.85–0.9), Military (Mach 2+), Experimental scramjets (>Mach 5).

Impact on aviation

- **Military:** Enabled supersonic fighters, strategic bombers, and stealth aircraft.
- **Commercial:** Reduced intercontinental travel times (e.g., Boeing 707 → modern airliners).
- **Space access:** Jet technology influenced rocket propulsion.

Figure 1: Jet engine technology relies heavily on advanced metallurgy to withstand extremely high temperatures during operation; additionally, modern engines incorporate thrust-vectoring nozzles that can rotate in multiple directions, providing greater manoeuvrability to aircraft



SOURCE: INCRED RESEARCH, COMPANY REPORTS

21st-century military aviation is driven by advancements in jet engine technology that deliver higher thrust-to-weight ratio

Modern combat aircraft require engines that provide maximum power with minimal weight, ensuring superior speed, agility, and fuel efficiency. This is achieved through:

1. **Advanced materials** (ceramic composites, single-crystal alloys) to withstand extreme heat while reducing weight.
2. **Improved thermodynamic efficiency**, allowing engines to operate at higher temperatures and pressures.
3. **Thrust-vectoring and variable geometry nozzles**, enhancing manoeuvrability in dogfights.
4. **Integration with stealth design**, requiring engines with lower thermal and radar signatures.
5. **Adaptive cycle engines**, which adjust airflow for supersonic or subsonic efficiency, improving range and performance

India is a decade behind the western world in modern jet engine technology

Why the US and Western nations are ahead?

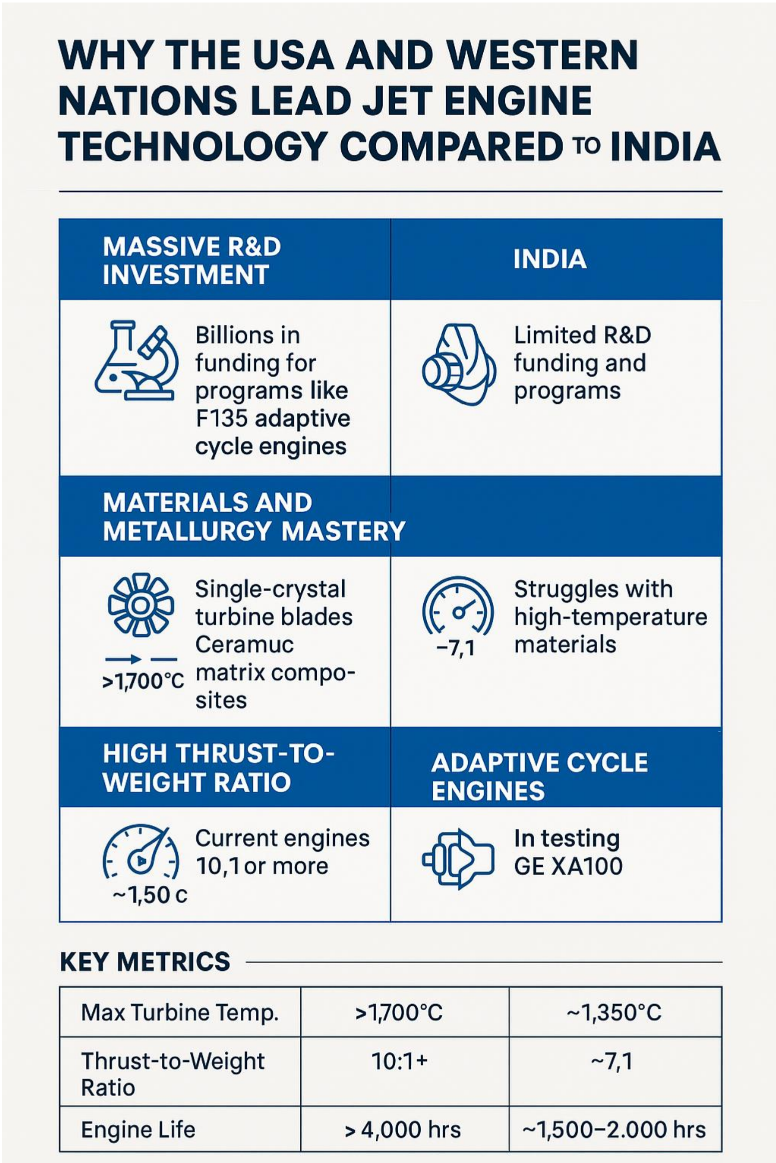
1. **Massive R&D investment:** Programs like the F135 (for F-35) and adaptive cycle engines (GE XA100, Pratt & Whitney XA101) receive billions in funding, enabling cutting-edge advancements.
2. **Materials and metallurgy mastery:** The US and the EU have perfected **single-crystal turbine blades, ceramic matrix composites**, and advanced coatings, allowing engines to operate beyond 1,700°C turbine inlet temperatures.

3. **High thrust-to-weight ratio:** Current engines (e.g., F135, EJ200) deliver **10:1 or more**, with high afterburner thrust for supersonic speeds.
4. **Adaptive cycle engines:** These next-gen engines can switch between fuel-efficient mode and high-thrust mode, extending range and performance dramatically.
5. **Supply chain & ecosystem:** Western nations have a vast network of suppliers, precision manufacturing, and decades of experience.

India's position

1. **India's Kaveri engine program faced challenges due to:**
   a. Lack of advanced metallurgy and high-temperature materials.
   b. Limited testing infrastructure and high R&D costs.
   c. Dependence on foreign OEMs for technology transfer.
2. **Current efforts:**
   a. GTRE Kaveri upgrade with Safran (France).
   b. Joint ventures for AMCA engine (6th-gen fighter) with Western OEMs.
   c. Indigenous efforts are improving but still 5–10 years behind Western standards.

Figure 2: India is decades behind the US and western counterparts in jet engine technology



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Years of limited investment and technological constraints have put India at a severe disadvantage in jet engine development and hence, modern aircraft development

High-powered jet engines are not just about speed—they are the backbone of a fighter aircraft's entire capability suite. Modern combat jets require enormous electrical power and thermal management capacity, which only advanced engines can provide. Critical systems such as 1) Active Electronically Scanned Array (AESA) radars (including future gallium nitride-based systems), 2) Laser-based weapons and targeting pods, 3) advanced avionics and sensor fusion suites, and 4) electronic warfare (EW) systems and jammers, all depend on the surplus energy and cooling provided by a powerful jet engine.

While India has developed strong capabilities in radar technology (with plans for indigenous GaN-based AESA radars) and electronic warfare systems, these advantages cannot be fully leveraged without engines that offer high thrust, efficient energy generation, and thermal resilience. This is why engine technology becomes the core enabler for a truly modern, lethal aircraft.

Currently, India's dependence on foreign engines for platforms like Tejas and upcoming AMCA highlights the urgent need for indigenous, high-performance jet engine development.

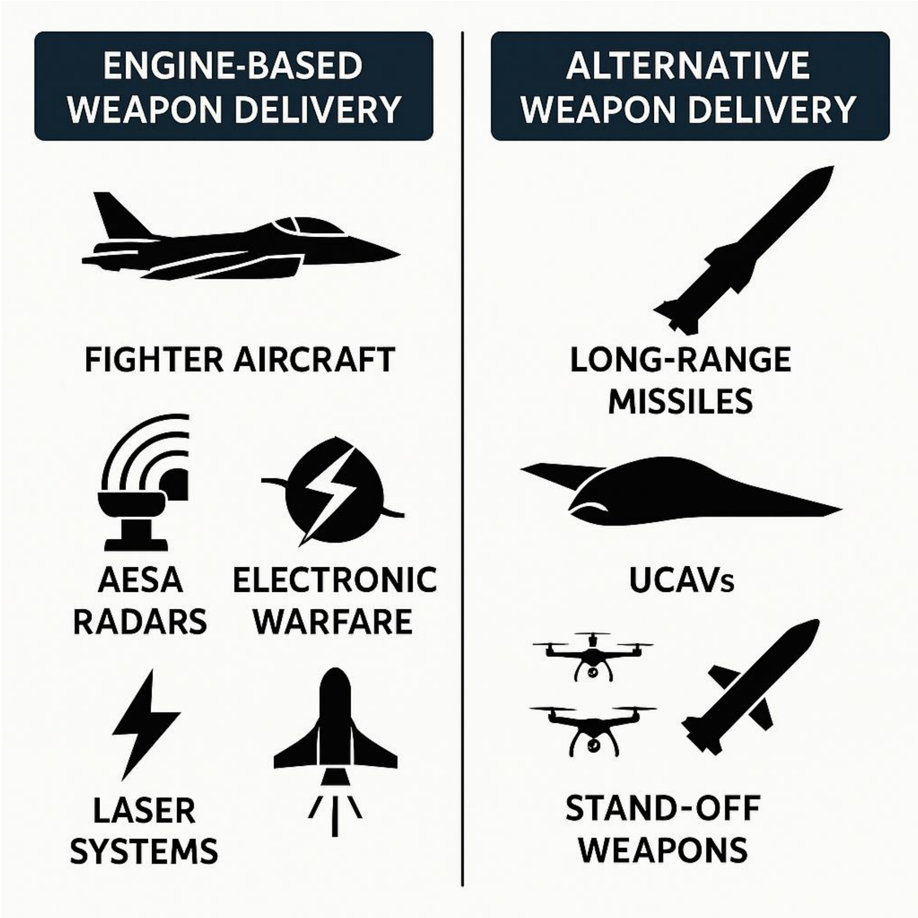
As usual, no one is going to give jet engine technology on a platter to India and hence, there is a need to develop weapon delivery technologies independent of manned fighter jets

Jet engine technology remains one of the most tightly guarded domains in modern defence. No country will transfer advanced propulsion systems on a platter, and India's experience with the Kaveri program reinforces this reality. While indigenous engine development must remain a long-term priority, India cannot afford operational vulnerability during this transition. The solution lies in building weapon delivery platforms independent of manned fighter jets.

1. **Long-range precision missiles -** India should continue advancing hypersonic and cruise missile technology, expanding programs like BrahMos-II and indigenous hypersonic glide vehicles. These can deliver precision strikes deep into enemy territory without risking aircraft.
2. **Unmanned combat aerial vehicles (UCAVs) -** Platforms such as Ghatak UCAV should be accelerated. UCAVs demand less propulsion power compared to manned fighters and can operate with smaller, less complex engines while leveraging stealth.
3. **Drone swarm technology -** AI-enabled drone swarms can overwhelm enemy defences and perform suppression of enemy air defence (SEAD) missions, reducing the burden on high-performance jets.
4. **Stand-off weapon -** Integration of long-range stand-off weapons on existing aircraft, including smart munitions and glide bombs, can keep pilots out of high-threat zones while achieving the desired effect.
5. **Space and high-altitude platforms -** Investment in space-based ISR (intelligence, surveillance, reconnaissance) and future orbital strike capabilities will redefine deterrence, minimizing reliance on jet engines altogether.

India already has strengths in **radars, electronic warfare, and missile systems**. Combining these with autonomous platforms ensures strategic depth until indigenous jet engines reach maturity. This multi-pronged approach is essential to maintain credible deterrence and combat readiness in the 21st century.

Figure 3: India is decades behind the US and western counterparts in developing jet engines which are essential for high quality jets; the solution is to develop alternate means of weapon delivery



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Big wars are ultimately wars of attrition to develop aircraft and bought-out engines are not a good solution because the supply chain can be stalled by the engine provider

Large-scale wars are ultimately wars of attrition, where sustainability of resources and production capacity decides the outcome. Relying on fighter aircraft powered by imported engines is a strategic vulnerability because:

- **Supply chain dependency:** In a prolonged conflict, engine suppliers can **stall deliveries**, either due to geopolitical pressure or export restrictions.
- **Maintenance and spares:** High-performance engines require constant maintenance and replacement of parts, which becomes a critical bottleneck if foreign OEMs control the supply.
- **Operational risk:** If the engine pipeline is disrupted, entire fleets of fighter aircraft could be grounded, reducing air dominance and deterrence.
- **Strategic autonomy:** Dependence on external vendors undermines India's ability to **sustain air operations independently** during crises.

Therefore, developing indigenous jet engines is not just about capability—it's about survivability in a long war scenario. Until India achieves self-reliance in engine technology, a parallel strategy should emphasize alternative delivery systems (missiles, UCAVs, swarm drones) that reduce reliance on foreign propulsion systems.

India's own engine is at least a decade away ➤

Currently, India is in negotiations with global engine manufacturers, including Rolls-Royce (UK) and Safran (France), to establish a partnership for developing an indigenous high-thrust jet engine. The objective is to co-develop an engine capable of powering India's future fighter platforms, including the Advanced Medium Combat Aircraft (AMCA).

However, a vendor has not yet been finalized. Once the partnership agreement is in place, the selected OEM will assist India in acquiring critical know-how in areas like advanced metallurgy, single-crystal blade technology, high-temperature coatings, and thermodynamic efficiency.

Even under a best-case scenario, the development and certification of a 110kN-class jet engine will take at least a decade due to the complexity of design, testing, and validation processes. This timeline means India will continue to depend on imported engines for its frontline aircraft—such as the LCA Tejas Mk-2 and initial AMCA variants—in the foreseeable future.

Hence, in between, India must rely on drones, missiles and SAM for its defence needs ➤

Aircraft are primarily weapon delivery platforms and critical for intercepting enemy aircraft. However, with India's falling fighter squadron strength and the need to prepare for a potential two-front war, the situation necessitates multiple new weapon systems to maintain combat capability.

Key considerations:

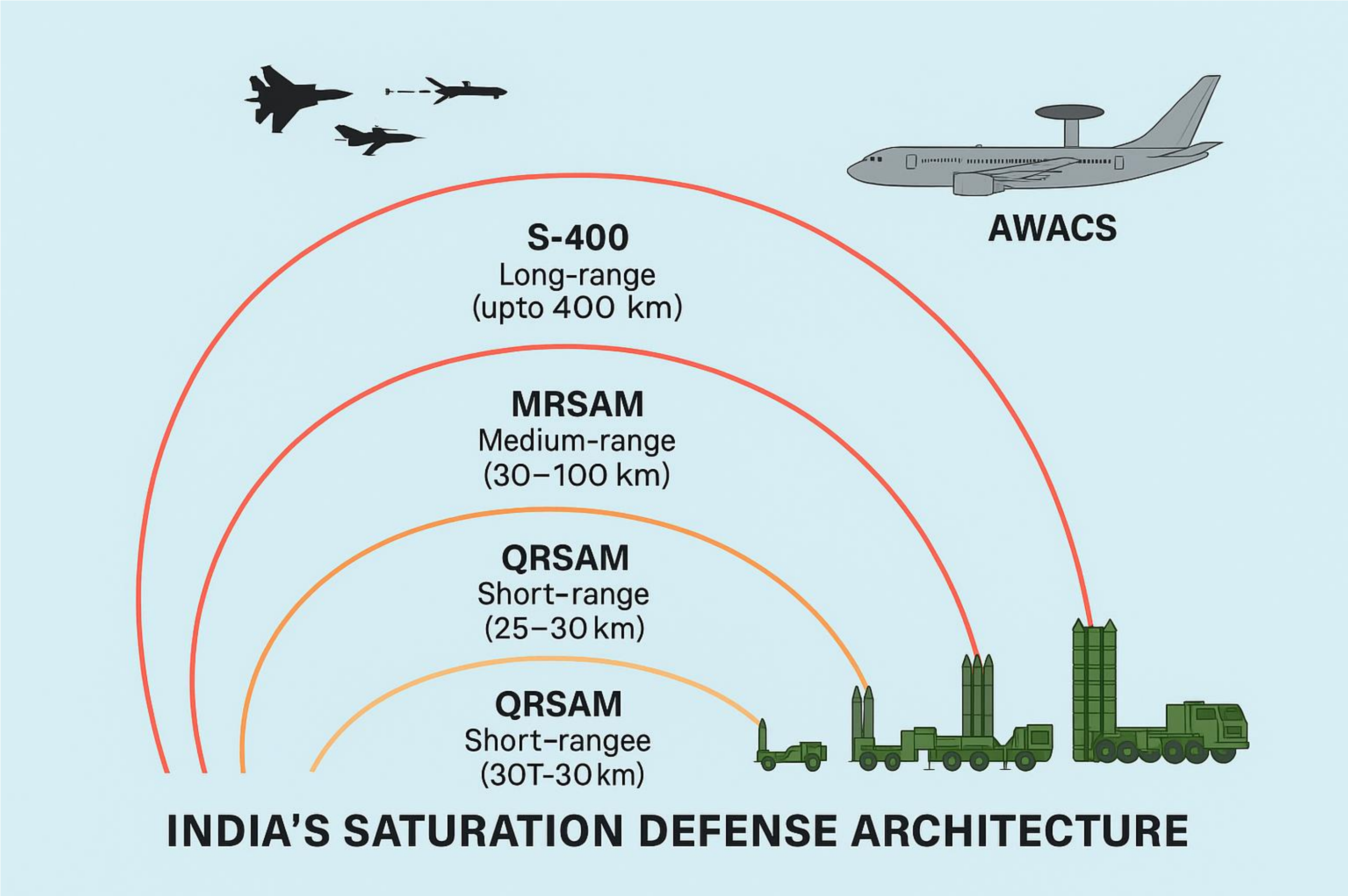
1. **Compensating for reduced fighter numbers**
    - A. There is no exact formula to equate how many drones or missiles equal one fighter aircraft in an offensive role, but these systems can provide distributed strike capability.
    - B. Investments in UCAVs, swarm drones, and long-range precision missiles will partially offset the decline in manned platforms.
    - C. Unmanned wingman aircraft (***Loyal Wingman concept***) are essential in modern air combat. These AI-enabled platforms operate alongside manned fighters, extending their reach, enhancing survivability, and carrying out high-risk missions without endangering pilots.
2. **Network-centric warfare**
    - A. Modern air combat relies on real-time data sharing and sensor fusion, where fighter aircraft act as key data nodes in the battle network.
    - B. In the absence of adequate squadrons, India must deploy more AWACS (Airborne Warning and Control Systems), ISR assets, and military satellites to sustain situational awareness and networked operations.
3. **Force multiplication**
    1. Integration of electronic warfare platforms, airborne sensors, and secure communication links ensures coordinated targeting, enhancing the effectiveness of drones and missiles.

This combined approach is crucial to offset squadron shortfalls, maintain deterrence, and ensure operational readiness in a contested multi-domain environment.

As of now, India needs near-saturation air defence – it's a US$25bn opportunity for the domestic industry

With jet engines at least a decade away and purchases of new aircraft being delayed due to red tape, India's only option is to buy local defence systems. India has developed multiple high-quality missiles and radar systems that can be procured locally at a fast pace. With dwindling squadron strength, this is the only way India can maintain aerial supremacy over Pakistan and prepare to fight a two-front war. The situation presents a US$25bn opportunity for the domestic industry.

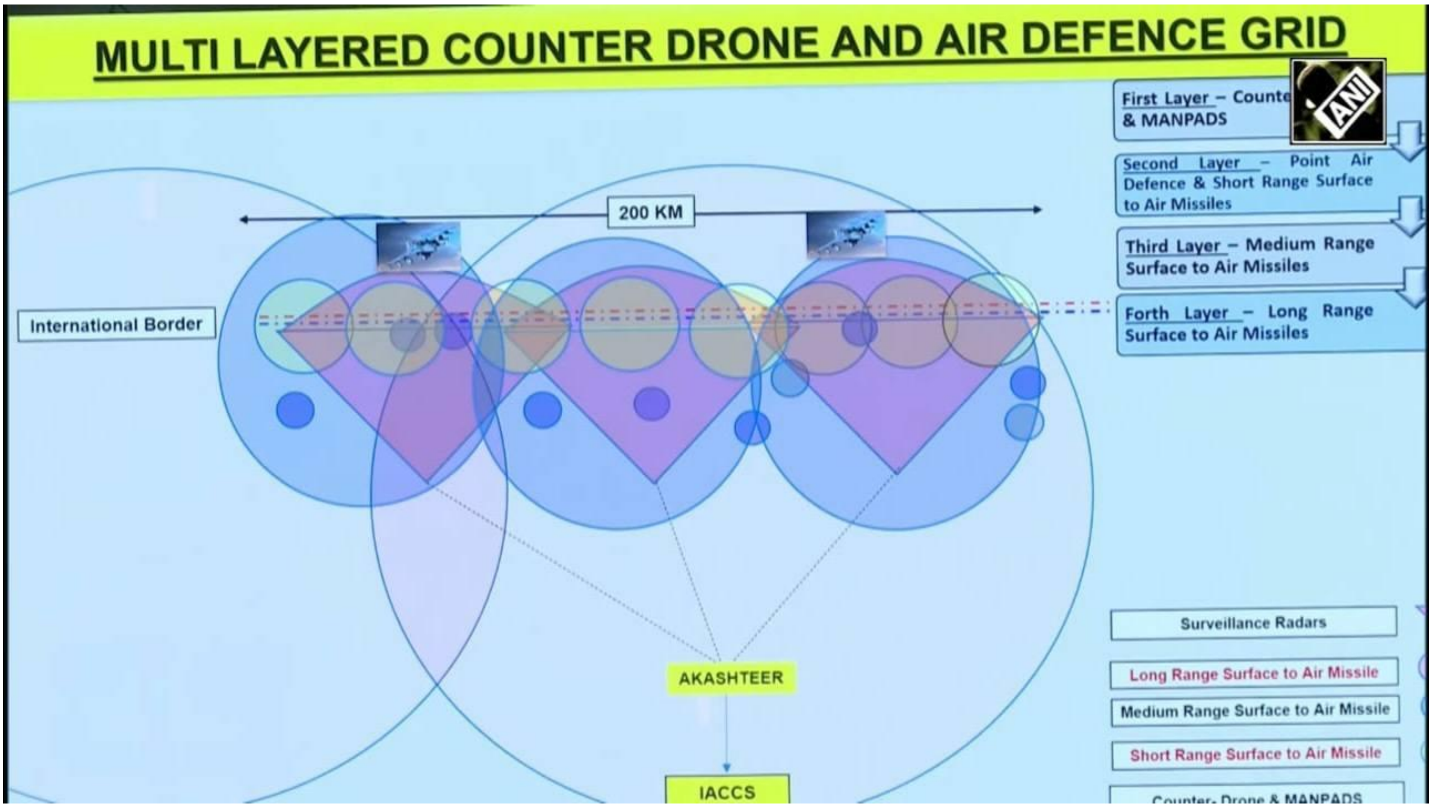
Figure 4: In an aircraft-deficient scenario, India needs saturation air defence



SOURCE: INCRED RESEARCH

So, how many SAMs does India need? In terms of the number of batteries for air defence roles - to alleviate the pressure on the Indian Air Force for the interception role - it's multiple times the current numbers

Figure 5: The structure of the Indian air defence network is shown in the graph below; we have taken this from ANI tweets



SOURCE: INCRED RESEARCH, HTTPS://WWW.FACEBOOK.COM/PHOTO/?FBID=1120514223436201&SET=PCB.1120514283436195

As of now, every air incursion leads to scrambling of jets from the Indian side and India needs multiple squadrons of interceptors as well. While the role of interceptors won't go away any time soon; however, more jets can be deployed for offensive roles if we have more air defence batteries. India needs addition at multiple levels.

1. Short range air defence batteries- We need multiple Akash systems and now Akash prime as well. Its range of operation is 4.5km to 25km with an altitude of 100m (metres) up to 20km.
2. Medium Range Surface to Air Missile (MRSAM) System-MRSAM was developed jointly by the Defence Research and Development Organisation or DRDO, Israel Aerospace Industries (IAI), and the Indian industry for use by the Indian army. The MRSAM army weapon system comprises multi-function radar, command post, mobile launcher system, and other vehicles. It has an advanced network-centric combat air defence system (ADS) and provides point and area air defence for ground assets against a wide range of threats. It can engage multiple targets at ranges up to 70km in severe saturation scenarios.
3. Close-range VSHORADS - India uses various small-range (5-15km) defence missile systems like Russia-made Igla, OSA-AK-M, Pechora, L-70 anti-aircraft guns and Israel's Spyder anti-aircraft guns.

How many Akash and Akash Prime missile systems are needed to completely saturate air defence of India's borders vis-a-vis Pakistan and China? We estimate orders worth US$6bn

Determining the precise number of Akash and Akash Prime missile systems needed to completely saturate India's border air defence against Pakistan is a complex calculation that involves classified military strategies, threat assessments, terrain analysis, and other sensitive factors. The India-Pakistan border spans approximately 3,323km.

1. Akash: A mobile, short-range surface-to-air missile system developed by DRDO with a strike range of 20km to 30km. It can engage targets at altitudes between 100m and 20km. Each battery can engage up to four targets simultaneously.
2. Akash Prime: An upgraded variant of Akash with an indigenous active radio frequency seeker for improved accuracy, especially in low-temperature and high-altitude environments. It has a range of 25km to 30km and a flight ceiling of 18km. Successful trials were recently conducted in Ladakh at over 15,000 feet to strengthen India's air defence along strategic borders.
3. Akash-NG (New Generation): A successor to Akash with an extended range of 70km to 80km and an improved reaction time for protection against saturation attacks. It works with seekers and so it's a fire-and-forget kind of missile.

Akash batteries in service - 34 batteries currently in service with the Indian military

1. IAF: 8 Mk1 Squadrons x 2 Batteries/Squadron = 16 batteries
2. IAF: 3 Akash Prime Squadrons x 2 Batteries/Squadron = 6 batteries
3. Army: 2 Mk1 Regiments x 6 Batteries/Regiment = 12 batteries

Akash batteries on order/being inducted- additional 20 batteries to be integrated into the Indian military's air defence

1. IAF: 4 Akash Prime squadrons are being inducted, which equals 8 batteries.
2. Army: 2 Akash Prime regiments are on order, totalling 12 batteries.

Remember saturation is not determined by linear calculations but depends on the threat perception, terrain as well as multiple others things. Also, please note that India has a big coastal area which also needs to be defended.

For simplicity, assuming linear deployment and that 70% of the Akash batteries are oriented toward Pakistan, they can provide saturation-level air defence coverage for approximately ***700km of border areas****. However, we emphasize that this is a very rough estimate and should not be considered a precise calculation—more of a starting point for discussion. If we assume the need for saturation-level air defence against* ***both China and Pakistan****, the requirement could be roughly* ***three times the current number of Akash batteries****. For context,* ***15 Akash batteries were exported to Armenia for about US$720m****. By extrapolation, procuring* ***around 100 batteries*** *could involve an investment of approximately* ***US$6bn.***

The requirement of MRSAM can be another ~US$8.5-9bn

Current known procurement

- **IAF:** 9 squadrons → ~2,000 missiles
- **Army:** 5 regiments → ~200 missiles
- **Navy:**~70+missiles
  Total available: ~2,300 missiles (approx. 100+ launchers across services).

Assumptions for saturation air defence

- **Threat:** A two-front scenario with heavy salvos of aircraft, cruise missiles, and drones.
- **MRSAM role:** Mid-tier layer (30–100km) between S-400 and QRSAM/Akash.

- **Coverage requirement:**
  - Western front (Pakistan): ~3,000km active border.
  - **Northern front (China):** ~3,500km active border, but intense threat only in ~1,200km sector.
  - Each MRSAM squadron/regiment defends ~60–80km sector effectively.

Force-level calculation

1. **IAF's current coverage**
   A. Nine squadrons = 9 × 70km = 630km.
   B. Barely covers high-priority zones on the western side; not enough for full two-front defence.
2. **For Saturation:**
   A. To cover 6,000km of critical border + key assets → need about 75-90 MRSAM squadrons/regiments.
   B. India currently has 14 units combined (9 IAF + 5 Army).
   C. Deficit: ~70 additional units.

Missile stockpile requirement

A. Each squadron/regiment holds ~150–200 missiles (initial + reloads) for saturation.
B. 70 additional units × 180 missiles = 12,600 more missiles.
C. Including reload capability (2 reloads per launcher): Add another 12,600 missiles.
D. Additional missiles for saturation: ~25,000.

As we have assumed linearity, hence the requirements will be less than the simple calculation; for the sake of simplicity, assume the actual requirement is 50% of the projected requirement; hence, the actual need of missiles is ~12,500

1. The MRSAM missiles cost around US$0.6m per missile and hence, cost of acquisition of 12,500 missiles will be ~US$7.5bn.
2. The firing unit cost per ~35 units will be around =25* 35= US$0.8bn.

Hence, the overall cost for these missiles and associated systems can be ~US$8.5-9bn.

QRSAM is the third layer of defence, and it will cost another US$9bn ›

QRSAM is an indigenous short-range air defence system developed by DRDO for the Indian army to protect moving armoured formations and high-value tactical assets against aerial threats such as 1) fighter aircraft, 2) attack helicopters, 3) UAVs/drones, and 4) cruise missiles.

QRSAM is indigenously developed by DRDO. It has a range of 25–30km (short-range layer). It is Intended for mobile protection of mechanized formations and close-in defence.

Cost benchmarks:

1. Each QRSAM unit (battery) = Rs4.6–5bn (US$55–60m) including radars & launchers.
2. Missile cost: Rs60–70m (US$700,000–850,000) per missile.
3. Each battery carries 6 launchers × 6 missiles = 36 ready missiles (plus reload stock).

Assumptions for saturation: Coverage requirement: Two-front war, protect forward forces + key installations.

1. Number of QRSAM units required: Current plans = 2 regiments (~6 batteries each).

2. Saturation for major sectors + strike corps = 10 regiments (~60 batteries total). So, additional 8 regiments (48 batteries) beyond current.

Missile stockpile:

1. Each battery requires at least 36 ready missiles + 2 reloads (108 per battery).
2. For 60 batteries → 60 × 108 = 6,480 missiles (round to 6,500).

Cost calculation

1. System cost (batteries + radars + C2) - Each battery: ~US$60m. 48 extra batteries × US$60m = US$2.88bn.
2. Missile cost - Each missile: ~US$800,000. Additional missiles: ~6,500. 6,500 × US$0.8m = US$5.2bn.
3. Infrastructure + logistics = Add 10% for reloading vehicles, maintenance, integration = US$800m.

In a jet engine-deficient scenario, S-400 must be used in attacking role

Our base line assumption for this report is the fact that dependence on foreign sources for jet engines will lead to delay, and Indian jet engines are at least a decade away . While India may acquire two-to-three squadrons of fifth generation aircraft, however, integration problems with the existing network will mean that they will work in isolation. That's why it won't be possible for Indian long-range missiles to team up with fifth generation aircraft.

S-400 in a attacking role means they attack Pakistani aircraft as soon as they become airborne and are caught by the S-400 radars. Remember, for this attacking, S-400 must be protected by batteries of Akash, XRSAM and MRSAM. However, Operation Sindoor showed that it can effectively be used in a attacking role.

India will also need multiple AWACS - India is already ordering six of them at a cost of US$6bn

AWACS can extend radar coverage to 400–500km, giving early warning and control to SAM batteries (S-400, MRSAM, QRSAM).

AWACS will detect enemy aircraft & cruise missile launches early. Coordinate multiple SAM layers (S-400, MRSAM, QRSAM). Integrate with ground-based radars and future IACCS upgrades for real-time targeting. Without AWACS, even the best SAM network becomes reactive instead of proactive.

New A321-based AWACS: Estimated cost is US$6bn for six units (≈US$1bn each with development costs).

SAMs address the need for interceptors; however, drones will be required to compensate for the lower number of attack aircraft - a multi-billion US$ opportunity

Surface-to-air missiles (SAMs) significantly reduce the need for traditional interceptors by providing an effective defensive shield against enemy aircraft and missiles. These systems can neutralize aerial threats at various ranges without deploying manned fighters, making them a cost-effective and rapid response solution. However, SAMs are purely defensive and cannot project power into enemy territory. To address the shortfall caused by the declining number of attack aircraft, drones become essential. Unmanned combat aerial vehicles (UCAVs) and loitering munitions can strike deep inside enemy lines at lower risk and cost compared to manned platforms. This combination of SAMs for air defence and drones for offensive operations creates a balanced, networked capability that compensates for the delay in procuring new fighter jets.

India needs a huge number of attack drones - be it home-made Nagastra or imported Harop drones - these requirements will be ongoing and again will be multi-billion US$ orders

Figure 6: To compensate for the air attack deficiency, India needs to Invest heavily in the attack drone infrastructure; thankfully, there are multiple Indian companies involved in this domain

System	Range	Endurance	Payload	Cost (Approx)
Nagastra-1 (India)	15km	30–60 min	~1–2kg	Rs1–1.2m (US$12–15k)
Nagastra-2 (India)	40+ km	60min	~2–3kg	Rs2–2.5m (US$25–30k)
Sky Striker (India-Israel JV)	100km	2hrs	10kg	Rs3.5–4m (US$45–50k)
ALFA-S Swarm (India)	25–30km	45min	~2kg	Rs5m–Rs10m per swarm
IAI Harop (Israel)	100km	6hrs	15–20kg	Rs80m (US$1m)
Switchblade-300 (US)	10km	15min	0.6kg	Rs5.5m (US$70k)
Switchblade-600 (US)	40km	40min	3.5 kg	Rs12m (US$150k)

SOURCE: INCRED RESEARCH, COMPANY REPORTS

1. It will be interesting to compare the cost of 1 Rafale aircraft with the drone. The cost of 1 Rafale (with weapons): ~US$250m (Rs20bn). With Rs20bn, one can buy:
   a. Nagastra-1: 1,60,000 units.
   b. Nagastra-2: 80,000 units.
   c. Sky Striker: 50,000 units.
   d. Harop (imported): 2,500 units.
2. Also remember, the Rafale comes with French weapons, and as Dassault Aviation has not shared the source codes with India, it means that Indian weapons cannot be integrated on the aircraft. This implies that (assuming no loss of aircraft during a sortie) each attack sortie of a Rafale jet will cost around US$10–12m for India, or approximately Rs1bn.

HALE and MALE UCAVs are also needed in huge numbers - estimated order size is at least US$4bn

HALE (High Altitude Long Endurance) and MALE (Medium Altitude Long Endurance) UCAVs are essential for:

1. Persistent ISR (Intelligence, Surveillance, Reconnaissance).
2. Precision strike in contested zones.
3. Communication relay & battlefield networking.
4. Substituting some fighter roles in low-threat environments.

Figure 7: Following is the comparison of various drones used by Indian military

Type	Platform	Range/Endurance	Payload
HALE	MQ-9B SeaGuardian	40hrs, 1,800km	1.5t
MALE	Rustom-II (Tapas)	24hrs, 250km LOS / 1,000km SATCOM	350kg
MALE	Heron TP (Israel)	30hrs	450kg
MALE	CATS Warrior (Wingman UCAV)	6hrs	250kg

SOURCE: INCRED RESEARCH, COMPANY REPORTS

For a two-front scenario (again assuming linearity and taking a 50% discount to the linear number**):**

- ~ 250–300 HALE/MALE UCAVs for persistent ISR & precision strikes.
- Thousands of loitering munitions (Nagastra, Sky Striker) for tactical roles.

Cost scenario

- 1 Rafale = US$250m. For the same cost:
  - 8 MQ-9B UCAVs (strategic reach);
  - Or 15–20 Rustom-II (indigenous MALE);
  - Or 50,000 Nagastra loitering munitions.

Drone swarms for the saturation, SEAD, ISR and target acquisition attack

Drone swarms enable saturation attacks by overwhelming enemy air defences. In theory, a simultaneous launch of 100,000 drones could saturate any air defence network globally, regardless of sophistication. While India currently lacks the capability to deploy swarms at this scale, it is technically feasible to field operational swarms of 200–1,000 drones, which can still impose significant pressure on enemy radar, missile systems, and command networks.

Following is the operational relevance of 200–1,000 drone swarms

1. **SEAD (Suppression of Enemy Air Defences):**
   - Use decoy drones + loitering munitions to exhaust enemy SAMs.
2. **ISR & target designation:** Preceding artillery and missile strikes.
3. **Saturation attack:** Against forward bases, artillery positions, or radar systems.
4. **Electronic warfare:** Jam or blind adversary radars.
5. **Cost advantage:**
   A. Even 1,000 micro drones (~Rs100,000–200,000 each) = Rs100m–200m total.
   B. Cheaper than a single Rafale sortie (Rs800m–1bn).

Indian drone startup ecosystem is quite robust and stands to benefit from the changing doctrine

India is actively developing indigenous technologies for drone swarms to offset its shortage of fighter jets and enhance offensive capabilities. Following organizations and the start-up ecosystem is actively involved in the swarm drone technology:

DRDO initiatives

1. **ALFA-S (Air Launched Flexible Asset - Swarm):**
   a. 4–8 drones launched from Su-30 MKI or other platforms.
   b. Mission: Reconnaissance, electronic warfare, decoys, and kamikaze roles.
   c. Autonomous swarm coordination using AI.
2. **Drone swarm demonstrators:**
   a. DRDO showcased 50-drone swarm in 2021 during the Army Day parade.
   b. AI-enabled distributed decision-making.

Indian start-ups

1. **New Space Research & Technologies:**
   - Leading developer of swarm AI and combat drone networks.
   - Demonstrated swarm of 100 drones for Indian Army.
2. **IdeaForge Technology:**
   - Focus on ISR drones, but working with defence for swarming solutions.
3. **Adani Defence & Alpha Design:**
   - Collaborating on tactical swarm UAV projects.

Following technologies needs to be mastered to move ahead on the bigger drone swarms

1. AI & swarm algorithms: Developed by DRDO & start-ups like NewSpace.
2. Secure data links: SDR-based anti-jamming communications.
3. Mesh networking: Resilient communication architecture for autonomous operations.
4. Electro-optical & IR sensors: For target detection and navigation.
5. Warheads & payloads: Miniaturized HE, anti-radar packages, EW pods.

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