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2021

FROST & SULLIVAN

DATA PATTERNS

Defence and Space Market Report Submitted to Data Patterns (India) Limited on 29 November 2021

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MACROECONOMIC OVERVIEW

Global Economy

Governments across the world have taken multiple initiatives to ensure minimal economic damage due to the impact of COVID 19. The world economy is expected to register a growth of 5.9% in CY 2021 and 4.9% in CY 2022. Beyond 2022, growth is expected to moderate to 3.3% in the near term. The rebound in Indian economy is forecasted to be much higher at around 8.7% in FY 2022.

The global economy is projected to grow at 5.9% in CY 2021[1] and 4.9% in CY 2022 as per the World Economic Outlook (WEO) released by International Monetary Fund (IMF) on 12 Oct 2021[2].

As compared to the WEO published in July 2021[3], the world economic growth has been revised downwards by 0.1% for CY 2021, while it remains unchanged for CY 2022. The downwards revision for CY 2021 is an outcome of reduction in growth outlook of Advanced Economies by 0.4%, balanced by upward revision of 0.1% in Emerging Markets and Developing economies (EMDEs).as shown below in Table 1.

Table 1: Global GDP outlook

Month	July 2021		October 2021	
Year	2021	2022	2021	2022
World Output	6.0%	4.9%	5.9%	4.9%
Advanced Economies	5.6%	4.4%	5.2%	4.5%
Emerging Market and Developing Economies	6.3%	5.2%	6.4%	5.1%

Note: Data from WEO published by IMF on 12 Oct 2021

Regarding the changed outlook, IMF view is, “The downward revision for 2021 reflects a downgrade for advanced economies—in part due to supply disruptions—and for low-income developing countries, largely due to worsening pandemic dynamics. This is partially offset by stronger near-term prospects among some commodity-exporting emerging market and developing economies. Rapid spread of Delta and the threat of new variants have increased uncertainty about how quickly the pandemic can be overcome. Policy choices have become more difficult, with limited room to maneuver” [4]

The CY 2022 global outlook has remained unchanged at 4.5% however with offsetting revisions; Advanced Economies outlook has been upgraded by 0.1% while

[1] All years in the economic forecast section pertain to CY unless specified otherwise
[2] https://www.imf.org/en/Publications/WEO/Issues/2021/10/12/world-economic-outlook-october-2021
[3] https://www.imf.org/en/Publications/WEO/Issues/2021/07/27/world-economic-outlook-update-july-2021
[4] https://www.imf.org/en/Publications/WEO/Issues/2021/10/12/world-economic-outlook-october-2021

that of EMDEs has been downgraded by 0.1%. The revised outlook is due to unequal access to vaccine in EMDEs.

The WEO outlines that 90% of advanced economies will regain their pre-pandemic levels of per capita income by CY 2022. This is in contrast to only one-third of emerging market and developing economies which are expected to regain their pre-pandemic levels of per capita income by the same time. The pandemic is reversing the progress made in qualitative aspects of life like food security and poverty reduction attained in EMDEs

In several EMDEs, elevated Covid19 caseloads, withdrawal of macroeconomic support and barriers to vaccination are offsetting the progress made in several indicators in the recent years. While the few commodity exporting nations in EMDEs are benefitting from the higher prices, other nations are suffering due to high cost of raw material which is negatively affecting their exports.

The overall rebound in economy is also indicated by recovery in the global manufacturing sector. Global manufacturing activity has firmed, and industrial production has surpassed its pre-pandemic level. In services sector, travel and tourism industry is still to recuperate from the blow of the pandemic however it shows a positive trend and is likely to recover to pre-pandemic levels earlier than previous estimates.

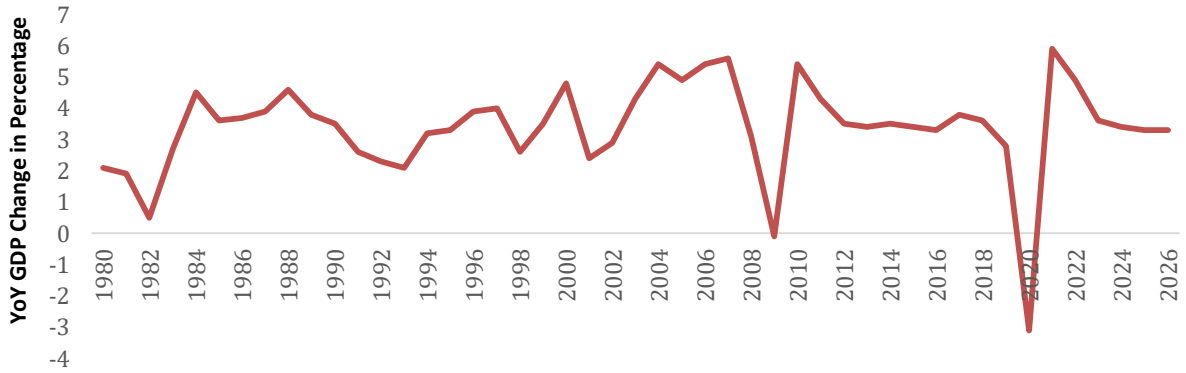
Contrarily, commodity prices have seen an increase in advanced nations. This is attributed to the improving global outlook and as well as commodity-specific supply factors. Recovery in commodity prices and in global activity from the reeling trough of the pandemic is contributing to an increase in consumer inflation, especially in certain EMDE's that have experienced currency depreciation. To a certain extent this was aggravated by the Suez Canal blockage in March (Ferrantino et al. 2021), consequently the terms of trade have deteriorated for EMDE's as they export more of primary products. However, it is to be noted that primary products have an inelastic demand in the short term resulting in a price rise for primary goods in the post pandemic period. There also has been a sharp rise in freight charges and localized shortages of shipping containers. In spite of many nations having adopted a combination of fiscal and monetary policy interventions coupled with an external trade policy strategy, in certain cases it was not sufficient to tide over the effect of the pandemic.

The pandemic induced disruptions and subsequent supply chain jeopardy exposed the contemporary vulnerabilities of existing supply chain. Motivated by economic nationalism and vulnerabilities in supply chain, many governments are actively promoting import substitution. However, the success of implementation would depend on consumers' disposition towards low cost goods, and principle of

comparative advantage would operate resulting in international trade and specialization.

Based on the above factors, the real GDP growth projections are as below:

Figure 1: World Real GDP Growth



Note: Real GDP growth figures from CY 1980 to CY 2020 are actuals; and for CY 2021 to CY 2026 are estimates. Source - IMF

(Source: https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/WEOWORLD)

To summarize, real GDP growth of the world is expected to be 5.9% in CY 2021, 4.9% in CY 2022, and expected to moderate to 3.3% in the near term.

Indian Economy

The Indian economy contracted by 7.3% in FY 2020-21[5]. However it has shown a strong rebound and is expected to grow by 9.5% for current FY 22 and 8.5%. for FY 23 as projected by IMF[6]. RBI also estimates the growth in FY22 at 9.5%, while it pegs the real GDP growth in FY 2022-2023 at 7.8%.

India has made rapid progress in its economy since the 2000s, which resulted in reducing absolute poverty. It is estimated that more than 90 million people were lifted out of extreme poverty in the period CY 2011-2015[7].

Indian economy grew at CAGR of 6.6% between 2012 and 2020 which was the highest growth globally, however it had started to slow down in the later years recording a growth of only 4.0 % in 2020. The slow growth was largely attributable to weakness in the financial sector and lower growth in private consumption. The woes were compounded by COVID when the implementation of lockdown in Mar 2020 (one of the most stringent lockdowns in the world), brought the economy to a near halt with rapid decline of both demand and supply. Consequently, there was a

[5] https://www.livemint.com/news/india/indias-gdp-contracted-by-7-3-in-2020-21-with-revival-postponed-to-202223-11622469188437.html

[6] https://www.imf.org/en/Publications/WEO/Issues/2021/10/12/world-economic-outlook-october-2021

[7] https://www.worldbank.org/en/country/india/overview

contraction of - 23.9 % in Q1 2020, and - 7.5% in Q2 2020[8]. The gradual opening of the economy towards the end of 2020 resulted in modest growth of 0.5% in Q3 and 1.6% in Q4 of 2020. For the full FY 2020-2021, contraction was pegged at -7.3%[9].

The drastic second wave of COVID led to another series of state level lockdowns, however it is being estimated that the economic effect of the same was much lower as the lockdowns were localised in nature. IMF in its WEO published Oct 2021 has forecasted a growth of 9.5% in FY 22 and 8.7% in FY 23[10], and is expected to maintain a growth of 6-6.5% thereafter in the medium term.

RBI has also maintained the forecast of 9.5% for FY 22 stating that 'the impact of elevated input costs on profit margins, potential global financial and commodity markets volatility and resurgence in Covid-19 infections, however, impart downside risks to the growth outlook". The economy is expected to clock 7.9% in Q2; 6.8% in Q3; and 6.1% in Q4 of 2021-22. Real GDP growth for Q1:2022-23 is projected at 17.2%. For 2022-23, RBI estimates real GDP growth at 7.8%, with quarterly growth rates in the range of 5.0-17.2%, assuming restoration of supply chains, a normal monsoon, no major exogenous or policy shocks, and full vaccination[11].

Impact of COVID 19 on Defence and Space Industry

The defence and space industry are strategic sectors, and are resilient to economic impacts. They are largely affected by geo-political situation, political stance and national strategic plans

Taking due account of the economic forecasts, Frost and Sullivan reiterates that the economic growth is not the pre-dominant factor which affects strategic sectors such as Defence and Space.

Defence spending unaffected by COVID impact

Defence spending trends show that its dependencies are multi-faceted, involving regional security climate, GDP growth, political stance, and equipment obsolescence; with geopolitics often emerging as the dictating factor when compared to economic factors. This can be discerned by the year on year increase in global defence spending by 2.6% to $ 1981 billion in 2020, and an increased spending by India in arms procurement representing an overspend of 18.6% over the budgeted capital acquisition amount. The primary reason for the same is increase in geo-

[8] https://www.business-standard.com/article/economy-policy/india-s-gdp-q2-2020-economic-contraction-narrows-to-7-5-from-23-9-in-q1-120112700855_1.html

[9] https://indianexpress.com/article/business/economy/india-q4-january-march-gdp-provisional-estimates-2020-21-fy21-gross-domestic-product-data-covid-19-surge-7338168/

[10] https://www.imf.org/en/Publications/WEO/Issues/2021/10/12/world-economic-outlook-october-2021

[11] https://economictimes.indiatimes.com/news/economy/indicators/rbi-retains-gdp-forecast-at-9-5-revises-inflation-estimate-down-at-5-3/articleshow/86883910.cms

political uncertainty at global and the national level due increasing Chinese aggression

Worst of supply chain and program disruptions are behind us

Defence Original Equipment Manufacturers (OEMs) faced early disruptions to supply chain and delivery due the pandemic related lockdowns. The disruptions lead to delay in delivery schedules of various programs, for e.g., Lockheed Martin delivered 120 F-35s in 2020-2021 which was 21 less than the planned figure of 141[12]. Lockheed Martin now expects to make good the shortfall by 2023[13].

Closer home, the sea trial of Indigenous Aircraft Carrier 1 (IAC 1) was delayed due to the effect of COVID. However, they have now commenced indicating that programs are getting back on track[14].

Most defence OEMs are planning to ramp up production within the next couple of years to make good on program delays. The ramp up will need to be supported by the supply chain, which had also suffered from disruptions and cash flow issues in 2020. Going forward, the financial health of defence supply chain constituents is expected to ease as the smaller companies were supported by larger OEMs and government initiatives both globally and in India.

Frost estimates that the disruptions will slowly ease out as the global vaccine program speeds up, and OEMs take concerted measures to scale up production. The worst of disruption is behind us, and no significant disruptions to production / cash flow are expected in the future.

The business landscape is changing with governments favoring indigenous supplier and domestic capability

The protectionism in defence that started manifesting in Europe a decade ago is becoming more widespread today. Governments want to leverage defence spending to make positive impacts on their economy, whilst preserving or expanding domestic manufacturing and its associated jobs. Imports from foreign suppliers may get deprioritized, creating opportunities for indigenous defence industries. The defence procurement policy and spending patterns are likely to be modified to obtain more value from defence budgets. Countries will look at spending the available resources more efficiently through indigenization (for e.g., India's Atmanirbhar defence structural reforms), diversification of supply chains, and looking at new more cost effective equipment sources, in order to keep procurement levels commensurate with achieving technology and platform based tactical advantages. The crisis forced countries are likely to rethink their procurement strategies by emphasizing more on

[12] https://www.airforcemag.com/lockheed-f-35-production-covid-longer-than-expected/
[13] https://www.airforcemag.com/lockheed-martin-hopes-to-catch-up-on-covid-delayed-f-35s-by-2023/
[14] https://www.newindianexpress.com/nation/2021/aug/08/iac-vikrant-returns-after-successfully-completing-five-day-maiden-sea-voyage-2341974.html

standardisation, modular design and its applications, and turning more towards commercial side technology baselines.

Industry stakeholders must take cognisance of the shifting landscape, and re-think their competitive strategy to align with domestic policy and offer higher value and lower lifecycle cost ability to the end users.

Resilience of space market

After initial disruptions in 2020, the global space sector has bounced back strongly in 2021. Q2 2021 saw a record $ 4.5 billion investment in the sector.

COVID-19 has been a strong influencing factor for market developments across sectors and geographies. However, space operations have remained fairly resilient to the negative impacts of the pandemic. Critical missions have progressed uninterrupted under special guidelines and safety protocols from government agencies. The industry has observed delays in project executions by a year or two, but complete loss of revenue opportunities have been relatively limited. While lockdown measures may have postponed launches, most contracts have remained unaffected. Despite the disruption, the number of launches in 2020 increased to 114 which was an increase of ~ 10% over 2019. Over 1200 satellites were launched in 2020. In 2021, there have been 63 launches during first half of the year with 1225 satellites being launched. The exhibited resilience of the space industry is mainly due to it being accustomed to vulnerabilities and uncertainties (such as weather conditions delaying launches) before COVID-19.

New investments in the industry have been affected to some extent, as a result of which some start-ups have had to shut down operations and file for bankruptcy. However there have also been instances of the investment changing hands. For e.g., Softbank's exit from OneWeb's start-up investment forced it to file bankruptcy initially however it was later rescued by a conglomerate which included UK government and Bharti Airtel. The UK government saw merit in the investment to support its post-Brexit objectives of achieving self-sufficiency in the space domain, while Bharti Airtel saw appeal in the promise of providing global connectivity. OneWeb, therefore, is back in the mega-constellations business, aiming to install its constellation by 2022. Investments in the sector have bounced back strongly in 2021, with Q2 2021 registering a record $ 4.5 Billion[15] of new capital. The total capital raised during 2021 is expected to exceed the $9.1 billion raised in 2020.

GEOPOLITICS

The Global Context

China's expanding military, newfound Russian assertiveness and a receding United States are driving the formation of new power centres; the scenario remains

[15] https://www.cnbc.com/2021/07/14/space-capital-q2-report-shows-record-4point5-billion-invested.html

escalatory which is expected to keep defence preparedness and spending at the forefront

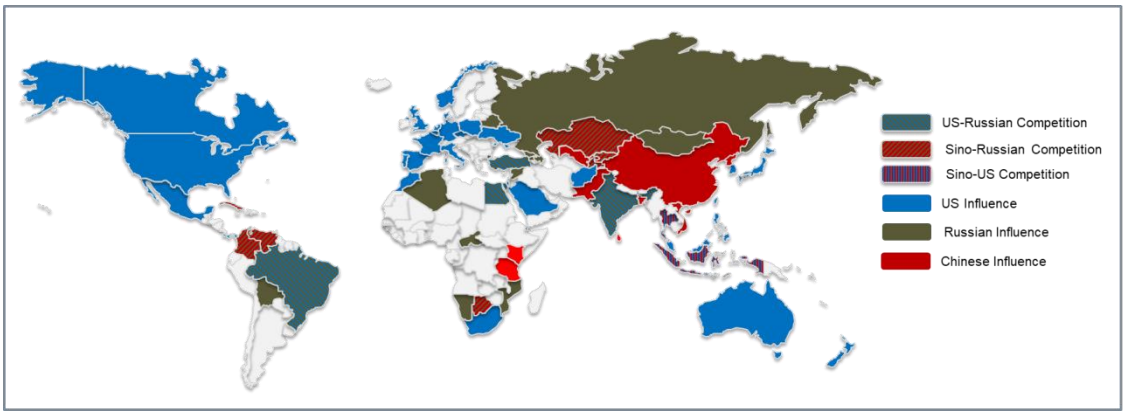


Figure 2 - Global Power Influences

The geopolitics of the world continues to be governed by a contracting sphere of influence associated with Western powers and the increasing geopolitical assertiveness of Russia and China. China's military modernisation has taken new hues over the last decade with a reformed focus on technological superiority and expanding expeditionary operations. The US Congressional Research Service report released on July 1, 2021[16] cites that the People's Liberation Army Navy (PLAN) is on track to have 425 warships by 2030. The PLAN already holds numerical superiority over the United States (US) as far as naval forces are concerned. While Chinese island-building activities in the South China Sea is contested by other stakeholders to the conflict, these stakeholders are also economically dependent on China and therefore are not willing to risk aggression at the cost of economic linkages. The Chinese Belt & Road Initiative[17], though ostensibly led by economic ambitions, have undertones of power projection and is seen by major countries as a risk in the current power calculus. China is also not shying away from open aggression if necessary, as evidenced by the skirmishes with India in the Pangong Lake area[18]. China's clamping down of freedoms in Hong Kong and it's encirclement of Taiwan are viewed by the West as potential threats, and the region is considered a dangerous flashpoint.

[16] https://fas.org/sgp/crs/row/RL33153.pdf
[17] https://www.cfr.org/backgrounder/chinas-massive-belt-and-road-initiative
[18] https://www.bbc.com/news/world-asia-57234024

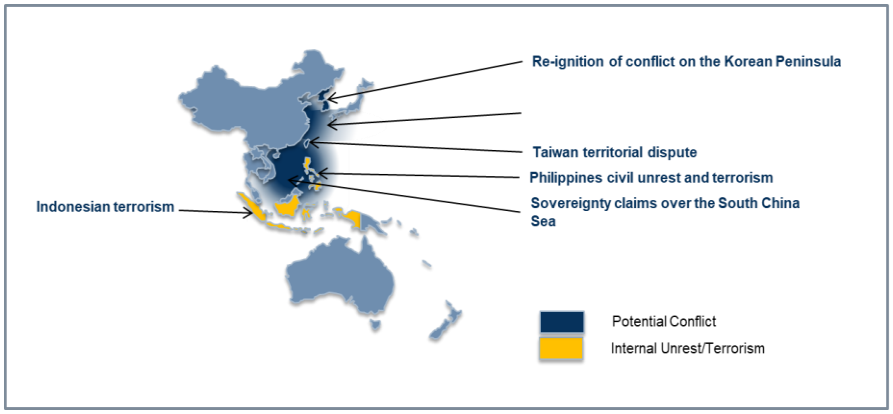


Figure 3 - Geopolitics in Asia Pacific

Figure 4 - The "New Silk Road" Initiative

Meanwhile, Russia has evolved from a silent to an overt aggressor, as exemplified by its takeover of Crimea. Putin's recent essay[19] on the "oneness of Russian and Ukrainian people", veils a possible takeover threat in the future. Russia has also started taking a more active interest in regional conflicts, having participated directly in the Syrian conflict. The Syrian conflict theatre witnessed Western equipment failing when going up against new Russian electronic warfare (EW) equipment, indicating Russia's new found technological superiority in certain segments of warfare (for example, spectrum warfare and hypersonic weapons). This event caused a recalibration in Western defence modernisation, accelerating military spending and refocusing on new technologies to counter new additions to the

[19] https://www.atlanticcouncil.org/blogs/ukrainealert/putins-new-ukraine-essay-reflects-imperial-ambitions/

Russian arsenal. Both these nations have also renewed their space programs, making it more offensive oriented[20].

Figure 5 - Russia's growing impact on global affairs

The US reaction to these developments, after Biden took charge, has been primarily inward focused and two pronged – expand technology intensive "force-multiplier" capabilities while detaching itself from external conflicts that drained its resources. The US withdrawal from Iraq and Afghanistan, and the expansion of the US Department of Defence budget to approximately $ 753 Billion in FY 2021 is in line with this new foreign policy. However, an exit of the US from these regions could catalyse regional players such as Turkey and Iran, or even larger powers such as Russia and China to fill the geopolitical void, exacerbating the security situation in these two countries. At the same time, the new Biden administration is likely to pursue a de-escalation policy with Iran, in order to reduce geopolitical tensions in the region. But by far, the highest risk is still the potential for a Korean conflict that would initially draw in the United States, China, and Japan but could spill over and involve many regional and global nations.

The US withdrawal is likely to have negative ramifications on terrorism in Afghanistan, Iraq and Syria. The Taliban has made a rapid emergence post the withdrawal of US troops, and has taken over power after seizing Kabul which forced the President Ashraf Ghani to flee the country[21]. The rapid collapse of Afghanistan, and re-emergence of Taliban will have wide spread effect on regional unrest with a

[20] https://foreignpolicy.com/2021/03/31/russia-china-space-war-treaty-demilitarization-satellites/#:~:text=China%20and%20Russia%20have%20sprinted,unfortunately%2C%20common%20in%20international%20diplomacy.
[21] https://apnews.com/article/afghanistan-taliban-kabul-bagram-e1ed33fe0c665ee67ba132c51b8e32a5

high possibility of it spreading globally inn dominant areas[22] . Though the Islamic State (IS) has been reduced to a smaller presence in Iraq and Syria, the threat has evolved into a new form of entrenched insurgency, with targeted local and regional attacks on weak points[23]. Terrorism spill overs due to US' withdrawal could be felt in other areas, including Pakistan, South Western China[24] and India, and will remain the major security concern after Chinese and Russian expansionism. The nature of threats have become manifold, and theatres of war are not restricted to ground, air and sea anymore. Militarisation of the cyber domain and space – especially by China and Russia, has driven powers such as the US, UK, India and others to strengthen cyber resilience and strengthen space based Intelligence, Surveillance, Reconnaissance (ISR) and offensive capabilities. Security stakeholders in these countries are increasingly turning towards new technological advances, including Artificial Intelligence and advances in Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) in order to develop an edge over the adversaries' technology.

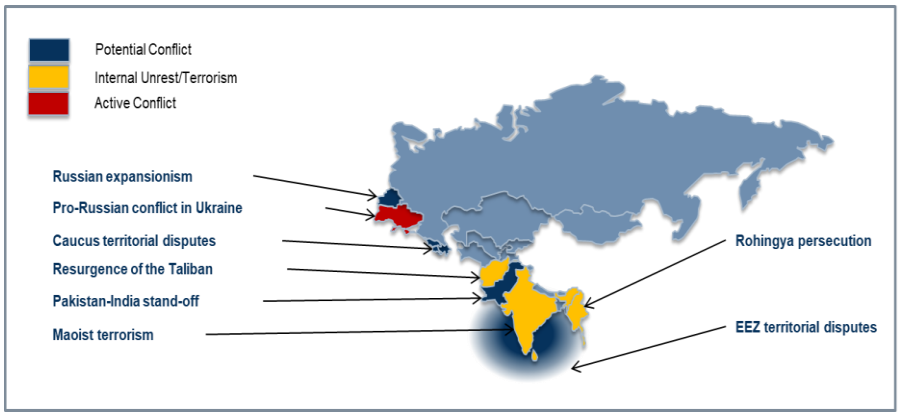


Figure 6 - Geopolitics in Central & South Asia

In Europe, the approach towards security is becoming more multilateral and European Union-centric; however, some intra-EU relations are becoming strained because nations such as Turkey and Hungary have entrenched relationships with Russia and China. The focus in the region is currently on collaborative defence projects such as the Future Combat Air System[25] and the European Medium Altitude Long Endurance (Euro MALE)[26] program. Defence budgets in the region are inching towards the NATO's target spending of 2% of a nation's GDP, driven mainly by Russia's increasing presence in Eastern Europe. The tempo and scale of NATO military exercises in the region are also growing; the power projection is expected to be a deterrent to Russia.

[22] https://www.bbc.com/news/world-asia-57933979
[23] https://www.voanews.com/middle-east/islamic-state-resilient-ever-iraq-syria
[24] https://asia.nikkei.com/Politics/International-relations/As-US-exits-Afghanistan-China-prepares-for-threat-of-security-void
[25] https://www.defensenews.com/global/europe/2021/05/21/fcas-developers-chasing-the-sweet-spot-in-mix-of-fighter-drone-designs/
[26] https://www.airbus.com/newsroom/events/ila-2018/EuroMale.html

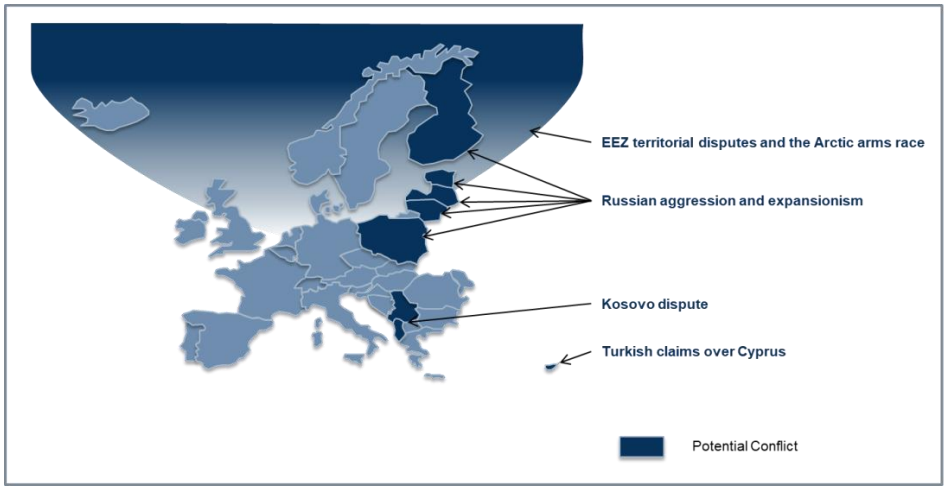


Figure 7 - Geopolitics in Europe

2021 presents a world that is rapidly becoming multi-polar through the rise of China and a potential resurgence of Russia influence in some regions. The threat of terrorism has not waned and could potentially increase over the next few years; for countries such as Afghanistan, India and Iraq insurgency will continue to be a perpetual security concern. As these perpetual threats expand and new technology based threats emerge, nations are increasingly looking towards the defence industry to provide a new wave solutions capable of delivering not only traditional tactical advantages, but spectrum-based, cyber, informational and space-based advantages.

The Indian Geopolitical Context

The Indian subcontinent's security situation remains in a very precarious state, with China's openness to confrontation on the rise and no abatement of terrorism from Pakistan. The tense geopolitical uncertainty will require increased defence preparedness

Territorial issues and a history of conflict spanning six wars have made India's borders with Pakistan and China some of the most dangerous flashpoints in existence today. The presence of such adversaries underscores the mandate for India to build up of credible, technology-driven military deterrence on both fronts.

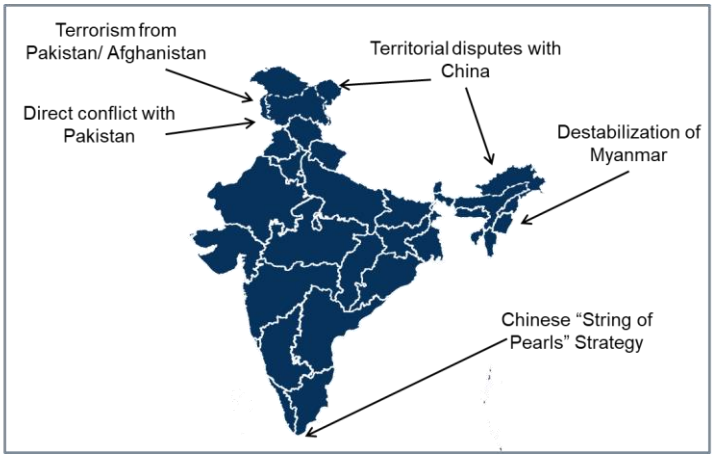


Figure 8 - The Security Situation in India

India's most pressing problems continue to be terrorism from Pakistan and a potential flare up with China. The taking over of Afghanistan by Taliban will further add to the security problems, with likely increase in terrorist's attack and cross-border infiltration. It is pertinent to note her that both China and Pakistan back the Taliban regime, and are mulling a strategy to recognise the government[27].

2020 witnessed the most violent clash between India and China in decades with both sides sustaining casualties[28]. A stalemate followed for the most part, however de-escalation was later agreed to with Chinese and Indian troops on the southern and northern shores of Pangong Tso disengaging in unison. Competing claims on territory along the Line of Actual Control still remain and therefore the region continues to be unstable. China's One Belt One Road (OBOR), though ostensibly a trade initiative potentially has elements to encircle India and erode its regional superiority[29]. China has forged close links with India's neighbours such as Sri Lanka, Nepal and Myanmar through a combination of investment and loans[30]. An increasing Chinese economic presence in these countries could mask or lead to Chinese intelligence or military activities, for example the Hambantota Port in Sri Lanka, financed through Chinese investments, could potentially be used as resupply points for Chinese warships and submarines as the PLAN pursues its plan to field a true blue-water naval force.

A permanent solution to the Jammu & Kashmir issue is unlikely and relations with Pakistan will continue to remain strained. Despite repeated commitments to peace talks by the leaders of India and Pakistan, attacks on the Indian Territory by terrorist organizations such as Lashkar-e-Toiba (LeT) and Jaish-e-Mohammed (JeM) continue. As Western powers such as the US have broken away from providing

[27] //economictimes.indiatimes.com/news/defence/as-china-pakistan-weigh-recognising-taliban-experts-warn-long-term-losses-us-ire/articleshow/85533435.cms
[28] https://indianexpress.com/article/india/galwan-valley-clash-timeline-india-china-disengagement-7358554/
[29] https://www.orfonline.org/expert-speak/from-hedging-states-trump-cards-china-backing-down-south-asia/
[30] https://www.thehindu.com/news/international/china-extends-500-million-loan-to-lanka/article34305277.ece

military supplies to Pakistan; China and Turkey have stepped in to fill the void. Further a resurgent Taliban, supported by China/ Pakistan, could have serious security implications for India.

DEFENCE TRENDS

Unmanned systems proliferation, an increasing focus on C4ISR and electronic warfare (EW), military commercial off the shelf equipment, and militarisation of space is driving the battlefield. Companies like Data Patterns which have an exclusive portfolio catering to the above segments will have significant opportunities in the future

Proliferation of Unmanned Solutions

Unmanned solutions used to be restricted to major superpowers only; now these solutions are becoming the new norm in warfare

Unmanned solutions are quickly becoming an operational norm in the land, sea and air domains. Several countries are in the process of modernizing their armed forces by improving the capability of their dismounted soldiers with improved situational awareness through a widespread adoption of unmanned solutions for a range of missions – including ISR, search and destroy and dedicated EW. Countries such as Turkey and Philippines have successfully demonstrated the use of Unmanned Aerial Solutions (UAS) for strike missions recently.

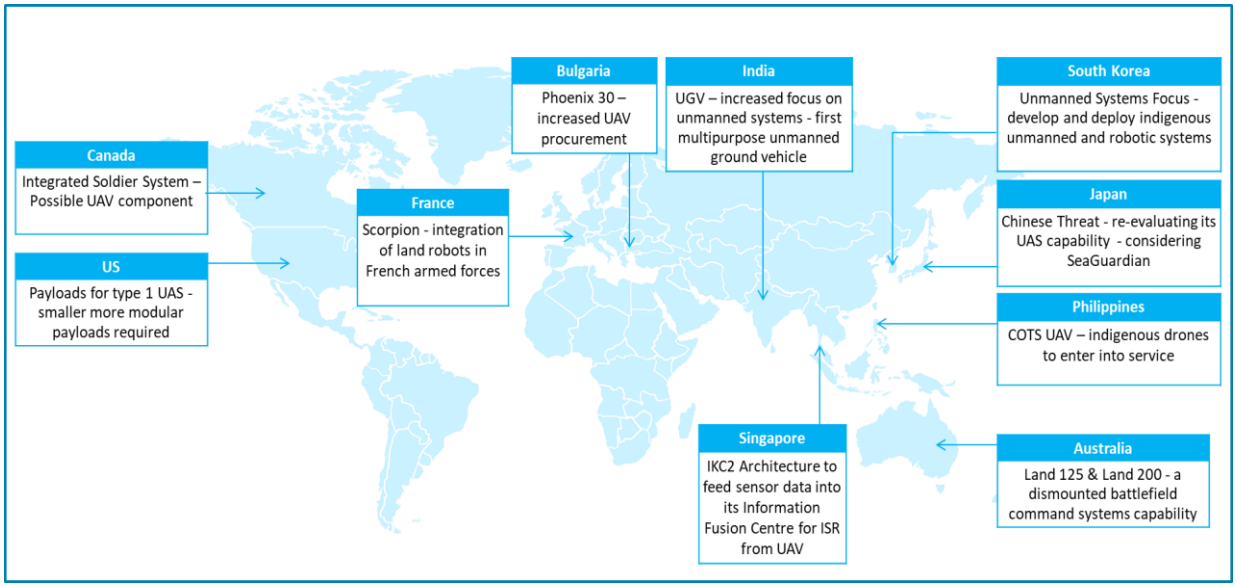


Figure 9 - Unmanned Solution Adoption by Countries

Over the past few years, on board capability and configurability of UAS have expanded to a high degree, with the latest iterations of UAS being multi-mission capable[31]. Operators are increasingly exploring formations in which manned platforms work in tandem with unmanned autonomous and semi-autonomous

[31] https://www.ga-asi.com/remotely-piloted-aircraft/predator-c-avenger

platforms (Manned-Unmanned Teaming - MUM-T) to achieve enhanced situational awareness. Globally, the U.S. Navy recently launched the Sea Hunter[32], designed to travel the oceans for months at a time with no on-board crew, search for enemy submarines and provide intelligence to naval commanders for better decision-making. Most new autonomous systems are being developed with cost effectiveness in mind and therefore a large portion of the technology and sub systems will be sourced from the commercial sector (which is more mature than the defence sector in autonomous technologies). The Indian Armed Forces is also expanding its armed inventory and is currently considering the acquisition of the General Atomics MQ-9 Predator UAS[33]. However, over time India will have to develop capable in-house unmanned solutions in order to procure more capability at lower cost.

Unmanned vehicles are becoming increasingly electronics dense and several companies in the Indian defence sector are well placed to cater to related emerging requirements for subsystems. This trend is expected to heavily influence the Indian Armed Forces' procurement dynamics and drive opportunities for tier 1, tier 2 and tier 3 Indian defence companies as procurement, especially for smaller and tactical Unmanned Aerial Systems, becomes more inward-focused.

New Standards in C4ISR and Network Centric Warfare (NCW)

Decision making in warfare, both at tactical and strategic levels, are increasingly being driven by information, high speed data transfer and network effects

Effective C3, supported by a reliable network composed of distributed ISR assets is a capability multiplier for military operations. Such technology was previously an asset of mostly advanced Western militaries; however, currently many smaller nations and developing countries are focused on expanding C4ISR and NCW capabilities. Solutions, which used to be exclusive to advanced nations such as the US, are becoming ubiquitous today especially in countries such as Turkey, India, and Saudi Arabia. C4ISR and NCW are prime drivers of future networked soldier programmes underway in France, Germany, Singapore, Malaysia etc.

[32] https://news.usni.org/2020/09/30/navy-to-use-sea-hunter-in-fleet-exercises-as-unmanned-systems-experimentation-continues

[33] https://www.hindustantimes.com/india-news/indian-navy-approaches-defence-ministry-for-predator-drone-acquisition-101622711168674.html

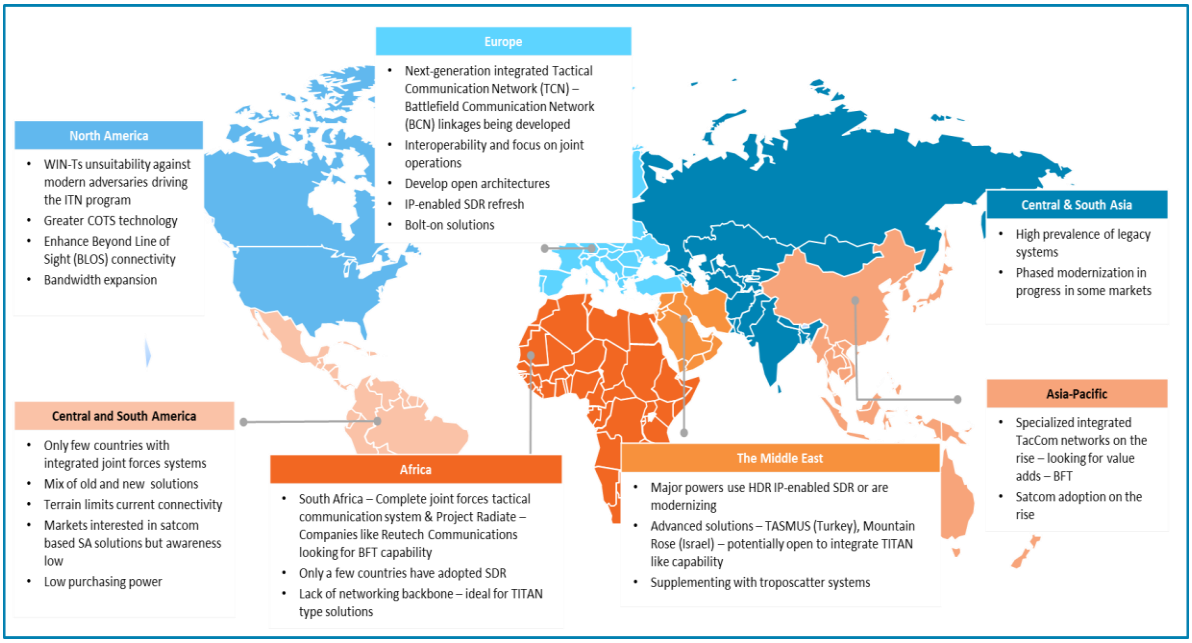


Figure 10 - Global C4ISR/ NCW oriented modernisation

In India, the progress towards an integrated battlefield network has been slow and currently put in the backburner because of lack of funds[34]. However, C4ISR upgrades have been happening in batches – through procurement of foreign equipment such as software defined radios from Israel[35] and also procurement of ISR equipment such as radar solutions from Indian indigenous companies such Data Patterns. Moving forward, especially after 2025 when India would have brought down equipment obsolescence in the forces, a more rapid adoption of C4ISR and network equipment can be expected. The majority of these requirements will be met through the indigenous industry, as Indian companies currently have the capability to build bespoke C4ISR solutions for the Indian Armed Forces.

Advances in Electronic Warfare (EW)

As global forces become increasingly networked, spectrum-denial is taking more importance as a high reward capability that can blind and overwhelm the enemy's operations.

Threat levels stand elevated today because adversaries have much better missile guidance and electronic warfare (EW) technology than a decade back. Expanding Russian and Chinese Electronic Warfare capabilities are a concern to several nations in Eastern Europe and South Asia. Both nations have demonstrated GPS jamming capabilities over the past few years. Russian jamming capabilities was a key concern to Western powers during the Syrian conflict as bespoke solutions were in place to jam GPS signals or spoof Position Navigation and Timing (PNT) markers.

[34] https://www.financialexpress.com/defence/battlefield-management-system-a-critical-technology-for-indo-china-border/1976041/

[35] https://www.timesnownews.com/india/article/iaf-to-buy-sdrs-from-israel-to-ensure-secure-communication-between-fighter-jets/461569

Norway has also been at the receiving end of Russian GPS jamming. Similarly India is concerned about China's expanding spectrum warfare capabilities. Russia and China both are also focusing on improving their space-based jamming capabilities.

Jamming Equipment used by Russia and their functions	
Solution	**Brief**
Murmansk BN	The "Murmansk-BN short-wave communications suppression complex" has been deployed in the Arctic and Northern Europe regions and is said to be capable of jamming communications in a radius of 5000kms. The solution jams short wave radio and high frequency GPS signals.
Krasukha-4	This solution focuses on jamming airborne assets including Low Elliptical Orbit (LEO) satellites.
Divnomorye	The EW solution seems to be specifically suited to jamming radar signals (ground or air based).
Leer-3	This UAS solution is designed to jam cell phones and VHF radio s active in an area.
Tirada-2	These two solutions focus on uplink jamming and target the satellites themselves as opposed to GPS signal receivers. They are designed to spoof the satellites, causing the satellites to spend their power in counter measures instead of on transmitting signals to the ground.
Bylina-MM	

Figure 11 - New Russian EW Equipment

A US Department of Homeland Security (DHS) report[36] states that using EMP weapons is a major part of the Chinese military paradigm. This underscores the need for EMP protection defence equipment. Most platforms being built today are EMP hardened through using hardened electronics, faraday shielded construction, EMP filters and redundant subsystems. In the future, a higher level of EMP protection that doesn't compromise on size and weight parameters of defence equipment will be sought after.

As most EW and Electronic Counter Measures (ECM) solutions need to be built bespoke to an operator's specifications and requirements to improve effectiveness, Indian defence stakeholders are turning more towards the indigenous industry. Indian defence component manufactures are embedded in the supply chains of Israeli and European defence majors that manufacture EW solutions. Moving forward, as the role of Indian Defence Public Sector Units (DPSUs) shift towards platform development and system integration, even more opportunities in the domain are expected to go to the Indian private defence industry.

[36] https://michaelmabee.info/china-emp-threat/

Commercial Off the Shelf (COTS) as a New Norm

Commercial Off the Shelf Components are fast becoming the building blocks of defence equipment, replacing bespoke components. The advantages of faster upgrades, plug and play and lower cost as a result of extensive COTS use are being recognized by major powers globally.

Economic pressures are driving many commercial and governmental operators within the military toward purchase of COTS products. These products have a favourable cost-to-performance ratio. Militaries are finding it difficult to improve the capability of its existing systems by relying solely on evolutionary upgrades achieved through its standard practices which they were not designed for. Advances in COTS hardware are thus enabling new opportunities for a hardware support model that facilitates continuous deployment of war fighting capabilities.

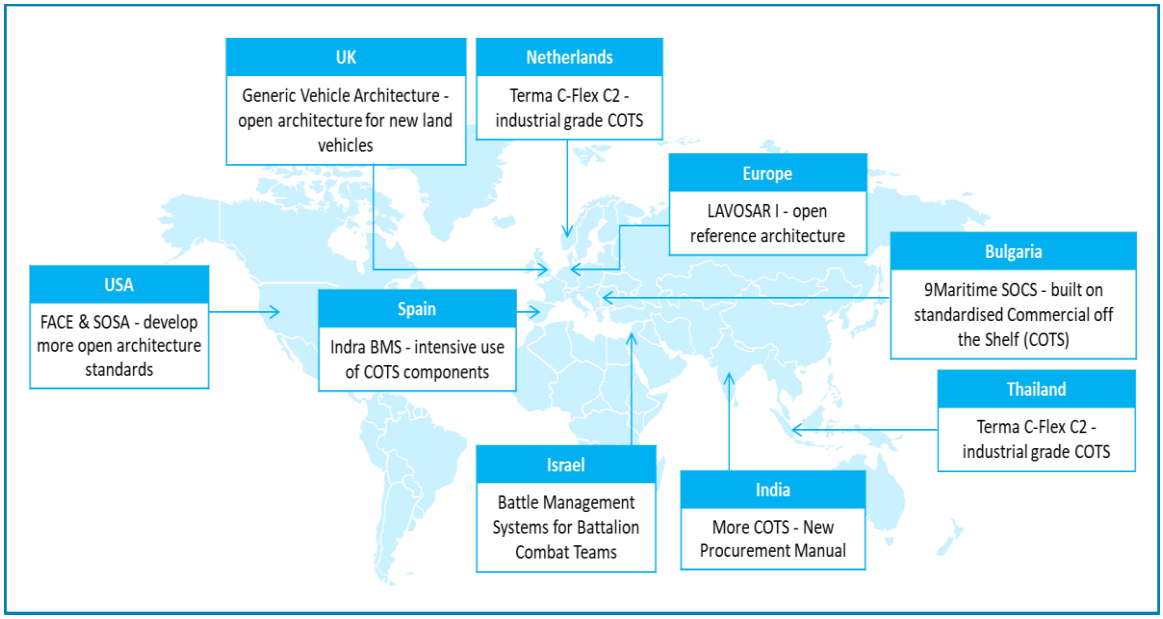


Figure 12 - Defence Programmes Requiring High COTS Use

In India, a new version of the procurement manual[37] of DRDO has been unveiled featuring simplified procedures for involvement of the private sector in various research and development projects. Measures include exemption of bid security and performance security of up to Rs 10 lakh (~USD 15000) and not having negotiations for commercial off-the-shelf (COTS) items/services. There is a continuous requirement of Commercial Off-The-Shelf (COTS) equipment available globally including manufactured indigenously for surveillance and communication besides solutions towards soldier protection and various security related platforms.

New Frontiers – Space & Cyber

The space and cyber domains are being weaponised rapidly, both for ISR and offensive operations. As militaries pursue digitisation aggressively, their susceptibility

[37] https://www.drdo.gov.in/sites/default/files/procurement-manuals-document/PM2020_0.pdf

to cyber-attacks also increases. Budgets towards cyber resiliency and space based weapon systems are on the rise.

The weaponisation of space is a Cold War era trend that is making resurgence because Russia and China are shoring up their capabilities in the two aforementioned areas. Major Powers have responded by devolving separate budgets towards the space and cyber commands and even setting up dedicated commands[38] for these new theatres. New technological developments, such as small satellites and cheaper satellite launch services have led to a thriving downstream business model providing ISR to several segments of customers, including the military.

As digitisation increases around the world, state and non-state actors are utilising the technology to spread their influence and presence, as well as wage cyber warfare, thereby opening up a new front. Cyber-proofing is emerging as a key mandated requirement among most advanced militaries. The advent of Internet of Things (IoT) has opened new avenues of infiltration, such as through networked household devices. The following trends will continue and become more prevalent:

1. A shift in attack methodology from data theft to data manipulation
2. Continuing lack of security skills in the workplace, making companies increasingly likely targets
3. AI, which will allow for a greater range and variety of attacks
4. Targeting of consumer devices through the IoT.
5. Supply chain attacks as a means of getting to larger companies

MoDs are continually investing in cyber security measures and adding cyber security requirements to technological developments to meet this growing threat. An example is the French 2019 new Military Cyber Strategy, with the commander of cyber defence (COMCYBER) being the head of the French MoD's cyber security.

DEFENCE SPENDING

Global Defence Spending

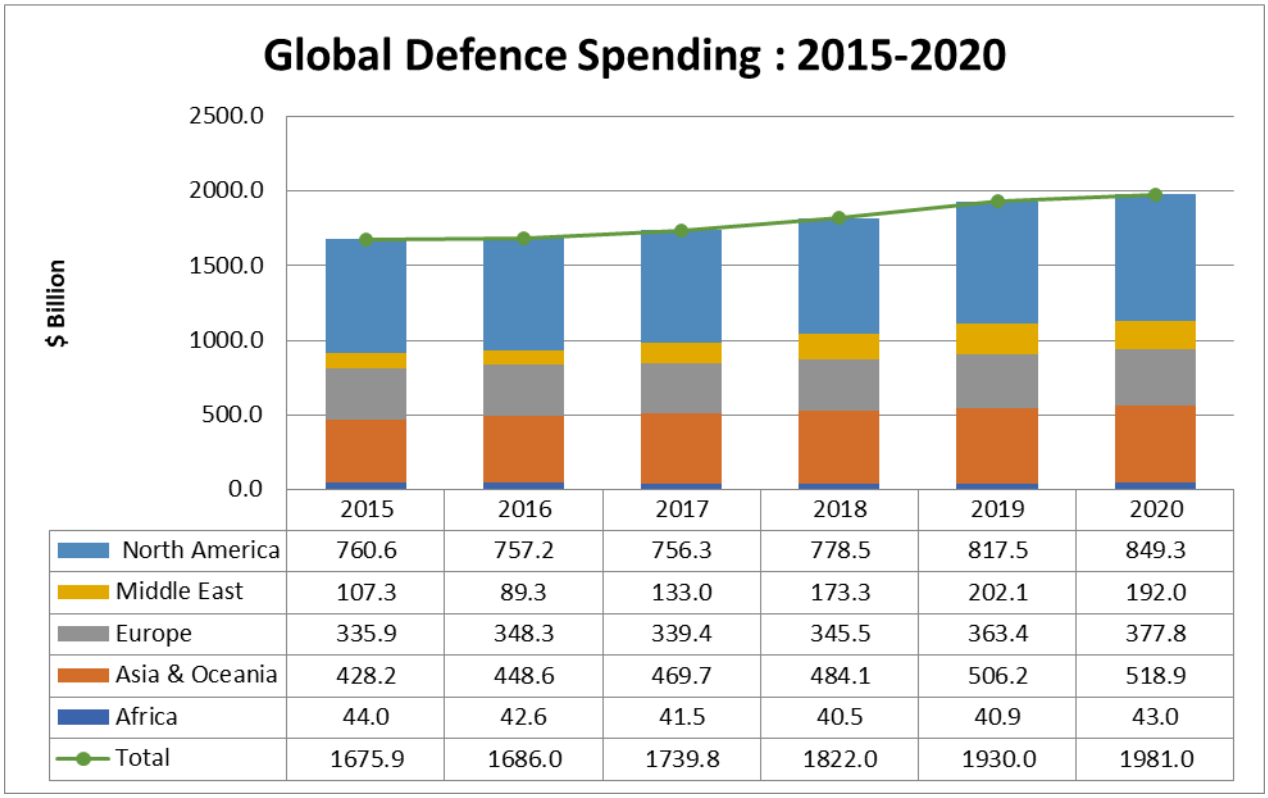
The global defence expenditure is expected to grow to $ 2031 billion by 2025 due increased geo-political uncertainty even though countries face economic pressures due to COVID 19 disruption.

The global defence spending rose to $ 1981billion in 2020[39] representing an increase of 2.6% over 2019 spending. The increase represents that the countries chose to spend more on defence even when they faced severe economic contraction due the COVID impact. As noted below, the global defence expenditure has been

[38] https://www.npr.org/2019/12/21/790492010/trump-created-the-space-force-heres-what-it-will-do

[39] Source: Stockholm International Peace Research Institute (SIPRI). All data in this section has been sourced form SIPRI

steadily increasing in the last 5 years at a CAGR of ~ 3.6%. As seen later, in this section the increase has been primarily due to the increased geo-political tension due Russian annexation of Crimea in 2014, followed by the aggressive actions of China in the wake of pandemic.



	2015	2016	2017	2018	2019	2020
North America	760.6	757.2	756.3	778.5	817.5	849.3
Middle East	107.3	89.3	133.0	173.3	202.1	192.0
Europe	335.9	348.3	339.4	345.5	363.4	377.8
Asia & Oceania	428.2	448.6	469.7	484.1	506.2	518.9
Africa	44.0	42.6	41.5	40.5	40.9	43.0
Total	1675.9	1686.0	1739.8	1822.0	1930.0	1981.0

Figure 13 - Global Defence Spending CY 2015-2020

Notes: The figures are based on current USD 2019. Figures for Middle East (ME) are estimates as noted by SIPRI. The years are calendar years.

The largest defence spender, US, is estimated to have spent $ 778 billion in 2020 which was an increase of 4.4 % over 2019. China, the second largest spender, is estimated to have spent $252 billion representing an increase of 1.4 % over 2019, while India was the third largest spender accounting for $ 72.9 billion with an increase of 2.1% over 2019.

Other notable facets of defence spending in 2020 are[40]:

- The top 5 spenders; US, China, India, Russia and UK accounted for 62% of the global defence spending. All five countries increased their spending by 1.9% to 4.4% over 2019.
- The top 15 spenders accounted for 81% of the total global spend; all the countries in this group increased their defence expenditure over 2019 except Saudi Arabia and Brazil which reduced defence spending.

[40] https://sipri.org/sites/default/files/2021-04/fs_2104_milex_0.pdf

- In 2020, thee military expenditure increased by 5.4% in Africa, 4% in Europe, 3.9% in Americas, and 2.5 % in Asia and Oceania. Middle East (ME) was the only region which registered a drop of 6.5%[41].
- Military expenditure in Africa was estimated at $43.2 billion in 2020, Algeria, Morocco, and South Africa were the top three spenders in the region.
- Americas spend a cumulative $ 855 billion in 2020 on defence representing an increase of 3.9% over 2019 US, Canada, and Brazil are the top three spenders in the region.
- In addition to China and India, Japan ($49.1 billion), South Korea ($45.7 billion) and Australia ($27.5 billion) were the largest military spenders in the Asia and Oceania region. The region has shown an uptrend since due rise of China as a global economic and military power which in turn has influenced the spend by other countries.
- Military spending in Europe was $378 billion; UK, Germany and France were the highest spenders in the region.
- The combined spend of the countries in ME was $ 143 billion. While the actual spending decreased, the military burden (military spending as percentage of GDP) increased due to the economic impact of COVID. The top three largest spenders in the region are Saudi Arabia, Israel, and Turkey.

The rise in global defence expenditure even in an economic downturn can be explained by the post-COVID rise in geo-political uncertainty. An examination of the variables affecting defence budgets shows that its dependencies are multi-faceted, involving regional security climate, GDP growth, financial deficits, political will and equipment obsolescence; with geopolitics often emerging as the dictating factor when compared to economic factors. Though theoretically, the defence expenditure was expected to decline due the economic downturn, the reality is that the main drivers of defence spending such as defence postures and geopolitics have only exacerbated in the recent times.

Rise in geopolitical disputes, such as the on-going flare up between the United States and China, was the major reason fuelling this increase in spending. Additionally, Chinese claims of territories in India, the South China Sea and the Asia Pacific (APAC) increased insecurity among the affected nations. Russia's involvement in Crimea and Libya, led to budget expansions of North American Treaty Organisation (NATO) members, many of which embarked on phased defence budget expansion plans to reach the spending mandate of 2% of their Gross Domestic Product (GDP).

Post-COVID-19 China is on an economic rebound and has displayed increasing military aggression against India and other countries, revitalizing defence spending in the affected markets. China also continues to improve military capabilities which

[41] Countries included in the estimate are Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia and Turkey. Data for other countries is not available.

matched with its increasing aggression is a source of global nervousness. At the same time, Russia is already ahead of Western nations in terms of military technology such as hypersonic weapon systems and electronic warfare, and if these nations push back defence programmes the technology gap between the two opposing groups will only increase. Because of these reasons, the US, most of Europe, India, Japan, UK, France, Australia etc., cannot deprioritise defence spending and Research & Development (R&D). Some nations such as Brazil, Saudi Arabia, Indonesia, have reduced their defence spending, but the top 15 spenders which account for ~ 80 % of defence spending are largely expected to maintain/ increase defence spending.

An additional factor to consider is that many operators sustain varying degrees of forward military posture and high operating tempo that cannot be wound down because strategic advantage will be lost. For example, India cannot reduce operations in its forward bases in the Ladakh or the Aksai Chin regions and NATO cannot cut down its forward operating presence in Eastern and South Eastern Europe.

Frost & Sullivan estimates that the defence expenditure will continue to rise in the medium term at a rate of 1.5% amounting to $ 2130B in 2026, largely influenced by the top 15 spenders even though some areas/ countries from the rest of the world may see a reduction in defence spending.

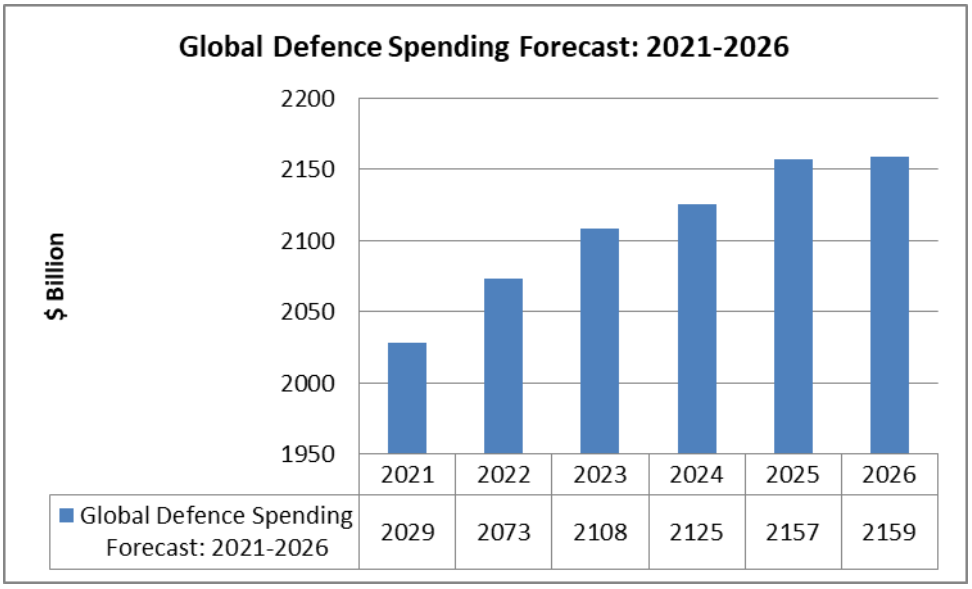


Figure 14 - Global Defence Spending Forecast: 2021-2026

Note: Forecast for period 2021- 2026 is based on Frost & Sullivan model in constant USD 2019 prices

The projected rise is based on an assessment of global GDP projections, and on assumption of continued political tension for next two years followed by a gradual easing of relationships. Any flare up in geo-political uncertainty due rise in tensions between US – China, India- China, India – Pakistan, Russia- NATO Israel-Palestine,

and re-emergence of Taliban at global theatre following the current situation in Afghanistan would likely result in significant upsides to the forecast.

Indian Defence Budget Brief and Forecast

There is a structural shift in the defence budget with increased allocation for modernisation funds, and approval of non-relapsable fund. The fund available to the defence industry participants during FY 2022-2031[42] is estimated at $ 339 billion.

The Indian defence budget has been growing at the rate of 7% in the past 5 years as below[43]:

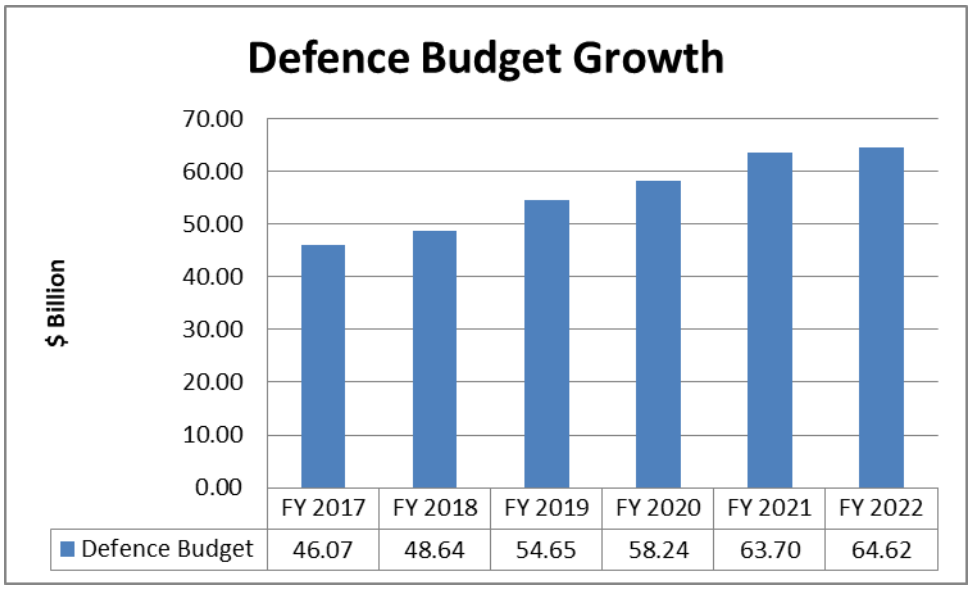


Figure 15 - Defence Budget Growth FY 2017-2022

The defence budget has 4 main components: MoD (Civil), Defence Services Revenue, Capital Outlay on Defence Services, and Defence Pensions, and not all of it is available to the defence industry participants. Examination of the allocation for different code heads for defence budget of FY 2022 ($ 64.62 B), and their description is as below:

[42] The defence budget discussion is based on India financial year

[43] The defence budget data is sourced from https://www.indiabudget.gov.in. The defence budget is announced in INR Crore (1 crore =10 Million). For the purpose of this report, all current and past budget figures have been converted to USD at an exchange rate of 1 USD =74 INR, so as to have an equal basis of comparison. The figures may not match with SIPRI figures due different standards of classifying defence expenditure, and variation in current USD conversion rate.

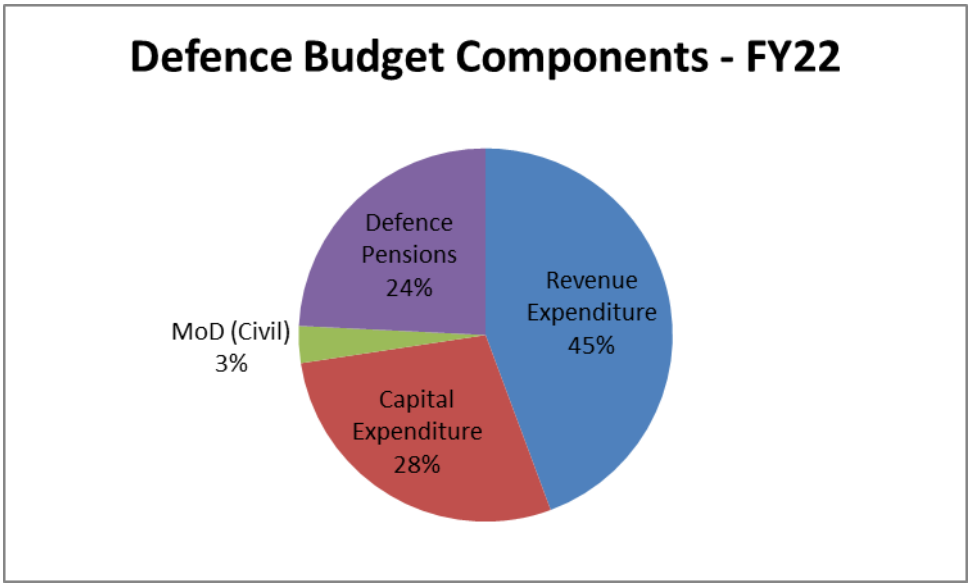


Figure 16 - FY 2022 Defence Budget Breakdown

Code Head	Description	Analysis
Revenue Expenditure	Defence Services Revenue comprises revenue expenditure of all the 3 services, in addition to expenditure of Ordnance factories, and Research and Development (R&D). The major heads are pay and allowances of serving personnel, transportation, works, stores, special projects, repairs and refits, and miscellaneous expenditure.	• The revenue component amounted to $28.65 billion / 44% of the total allocation in FY 22. • Most of this budget is not directly available for defence industry participants with the exception of stores, repairs, and special projects. • The total amount available to defence industry participants is $ 6 B in the current year
Capital Expenditure	The Capital Outlay on Defence Services encompasses all the acquisitions expenditure of the three services in addition to the capital acquisition of ordnance factories, R&D, DGAQA (Director General Quality Audit) and prototype development under the Make procedures.	• The allocated capital expenditure amounted to $18.25 billion / 28 %. in the defence budget FY 22
MoD (Civil)	MoD (Civil) deals with the expenditure of the civilian	The allocation is not available to the defence industry, and amounted to $2.06

Code Head	Description	Analysis
	personnel in defence services.	B / 3% in FY 22 budget
Defence Pensions	Defence Pensions is allotted for pension and allowances of retired personnel	• This allocation is not relevant to the market, amounting to $15.66 billion / 25% in FY 22 budget • Various measures are being deliberated to reduce the defence pension outgo which includes increasing the retirement age of the officers and Personnel Below Officers Rank. The move is likely to affect 50,000 personnel and reduce the pension outgo in the medium term [44]

Table 2 - Defence Budget Components Description

An examination of the defence budget components in the above table shows that the amount available to the defence industry participants for FY 22 Budget is $ 24.25 billion.

Frost and Sullivan would like to highlight that the allocation directly benefiting the industry is more relevant for the purpose of this report as compared to the total defence budget which includes salaries, pensions and miscellaneous expenditure.

Analysis of past trends shows that the total allocation which directly benefits the industry has grown at rate of 7%. The growth rate in the period FY 2017-2019 was significantly below the average growth rate as a ballooning salary and pension bill consumed a larger portion of the total allocation. In contrast, the growth rate in FY 2020, 2021 has been 10.5% and 4.9% respectively, while the increase in FY 2022 is a staggering 14.9%. Additionally, FY 2021 was characterized by an overspend of 18.6 % above the budgeted capital allocation on back of the emergency purchases following the face off with China

[44] https://theprint.in/defence/why-modi-govt-will-be-spending-less-on-defence-pensions-next-year/596768/

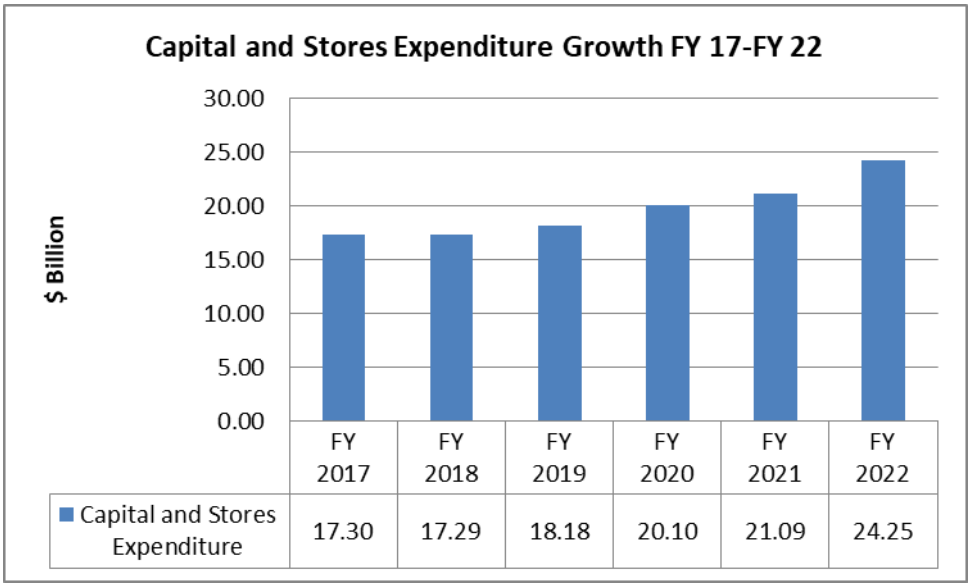


Figure 17 - Capital and Stores Expenditure Growth: FY 2016-FY 2022

The acceleration in the capital and stores procurement represents a structural shift in the budget which earlier catered mostly to salaries and pensions without providing sufficient funds for modernization. No doubt, it comes on back of increase in geo-political tension which has made the Indian Govt. take stock of the delays in the much needed modernization program. The increases was also facilitated by decline in pension out go from $17.9 B in FY 21 to the current year allocation of $ 15.66 B; a decrease of $ 2.24 B. Going forward, it is expected that the pension share in the total defence budget will largely remain stable with implementation of intended measures as recorded in Table 2 .

Frost and Sullivan modeled the factors which are likely to influence the growth trajectory of Capital and Stores allocation with weighted consideration of:

- Historical Trend: The historical trend of capital and stores allocation shows a compounded growth of 7%, with the current year allocation exhibiting an increase of 14.9%. It is pertinent to note here that the growth rate of FY21 budget allocation both in capital and stores procurement was influenced by the emergency purchases, some of which will be paid in the current fiscal year on delivery. The growth rate is expected to moderate in successive budgets.
  Geo-Political Situation: It has been assumed that the current increase in geo-political tension with China, and Pakistan will continue for next two years after which there will be gradual return to previous state of affairs.
- GDP Growth – GDP growth has been assumed at 10.5 % for FY 21, 7% for FY 22, and 6% for the rest of the forecast period. In this respect, due cognizance has also been taken of the measures to relax fiscal deficit targets which would allow greater expenditure by the government[45]. Modernisation Program and Delays – The modernization program has been largely affected in the past years by bureaucratic delays and differences of opinion between

[45] https://prsindia.org/budgets/parliament/union-budget-2021-22-analysis

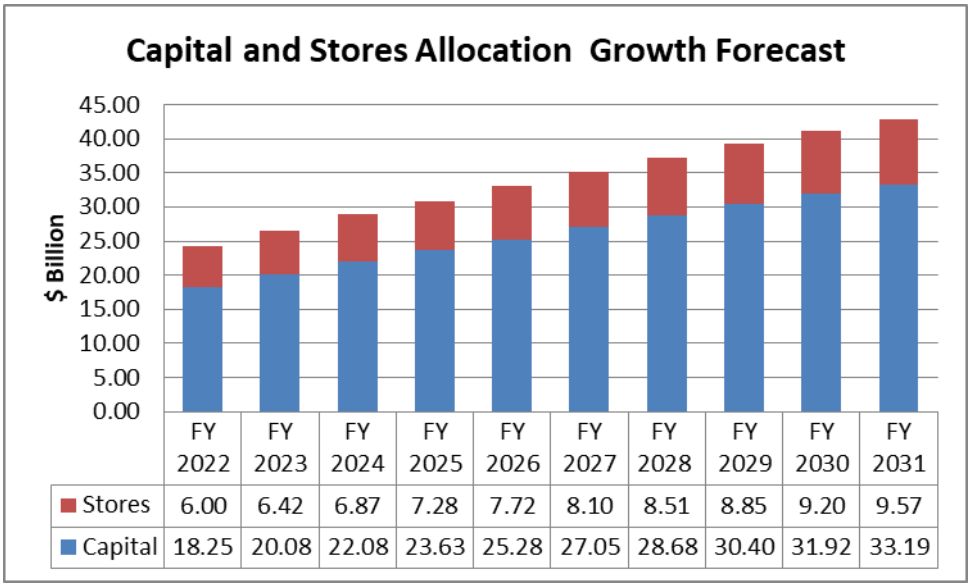
different stakeholders such as the MoD, the armed forces and the defence public sector units. It is assumed that the delays will reduce over the forecast period due greater realization of the poor state of military equipment especially after the Chinese aggression. Frost expects a greater cohesion, effective policy implementation, and larger participation of the private industry on account of the government push to create a level playing field, to accelerate the modernization program

- Creation of Non-Lapsable Defence Modernisation Fund –The capital acquisition budget has been much lower in the past when compared to the projected requirements of the defence forces. For e.g. the gap in FY 22 capital budget projection by defence forces and actual allocation was $ 7.8 billion[46]. To bridge this gap, the 15th finance commission recommended setting up of a non-lapsable modernization fund[47]. The total size of this fund for the period 2021-2026 is indicated as $ 32 billion with maximum accretion of $ 7 billion per year. The finance commission report states that, "The incremental funding will come from transfers from the Consolidated Fund of India, disinvestment proceeds of defence PSUs, proceeds from the monetisation of surplus defence land, including the realisation of arrears of payment for defence land used by state governments and proceeds from defence land likely to be transferred to states and for public projects in future".
- Technology Incorporation – Technology incorporation in the forecast period will allow the forces to become a leaner and more efficient force with consequent benefits to the salary outgo.

Based on the above factors, the capital and stores allocation is expected to grow to $ 33.19 billion and $ 9.57 billion respectively by FY 2031 The cumulative amount available during the forecast period would be $ 339 billion.

[46] https://www.financialexpress.com/budget/budget-2021-22-meeting-defences-requirement-a-big-challenge/2157394/

[47] https://www.moneycontrol.com/news/business/budget/government-okays-15th-finance-commissions-proposal-for-non-lapsable-defence-fund-6505991.html



	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031
Stores	6.00	6.42	6.87	7.28	7.72	8.10	8.51	8.85	9.20	9.57
Capital	18.25	20.08	22.08	23.63	25.28	27.05	28.68	30.40	31.92	33.19

Figure 18 - Capital and Stores Allocation Growth Forecast

Salient features of the forecast are as below:

- Although the Indian Army is the largest service, the IAF and IN will share 70.0% of the total capital acquisition budget, with the Indian Army's share at 30.0%. This is due to lower equipment cost and the slower pace of modernisation in the Indian army.
- Aircraft and aero engines make up 32% of the total cumulative opportunity, with big-ticket acquisitions on the cards. India is set to induct about 200 fighters in addition to ISR, AEW, rotary, and unmanned assets.
- The naval fleet, which includes the induction of IAC 2 and submarines under Project 75 I (the Indian Navy's acquisition of new diesel electric submarines, with Air Independent Propulsion), would form the next major component at 13%.
- Weapons and defence electronics will see a major uptick in acquisition, as the Indian forces look to upgrade their operational engagement and network-centric capabilities

INDIA DEFENCE MODERNISATION PROGRAMMES

Delays in modernisation caused a major reduction in offensive capabilities of the Indian forces. Considering the escalating geopolitical scenario in the Indian subcontinent, process improvement and industry push mechanisms to accelerate defence procurements is expected. Most modernisation programs are either totally indigenous or are planned to have a large indigenous component which will drive the indigenous growth. DRDO (Defence Research and Development Organisation) is the research and development agency which develops the indigenous programs Companies like Data Patterns which supplies to DRDO for the developmental

programs gain a competitive advantages it becomes the preferred (and often sole source) supplier as the program shifts to production stage

The Indian Armed Forces currently operates in a state of reduced commissioned capacity. For example, the IAF currently has 30 fighter squadrons against a sanctioned strength of 42 squadrons. Additionally, it has a very limited number of Airborne Early Warning (AEW) aircraft and tankers that are woefully inadequate to meet its operational demands. The Navy operates a sole air craft carrier and has been pushing for an additional two. IAC 1 has commenced its sea trials after a delay and is likely to be inducted in early 2022. India needs three carriers Navy to counter Chines Navy's aggressive naval modernisation, and the construction of IAC 2 is slated for later half of the decade. The Indian Navy has issued an RFI for 56 carrier-based fighters, and the process is still on-going. Indian Army troops suffer from shortages even in some basic equipment. For example, a recent Comptroller Auditor General (CAG) report indicated that there was a shortage of snow goggles, boots, jackets, and sleeping bags for the troops stationed in high-altitude areas. The Army's platform modernization effort has been lagging behind the other two services and many projects are expected to be realized over the next 3-7 years. India will have to procure replacements for its ageing Boyevaya Mashina Pjehoty (BMP) fleet in order to maintain suitable capabilities for its mechanized infantry.

Delays in modernisation programs have led to back log and reduced offensive force which is now becoming untenable in view of the large deficit and increased political tension with China and Pakistan. Frost estimates that the modernisation programs will be accelerated in the future due policy reforms and larger participation of private sector participation. The modernisation programs of IAF, IN and IA as listed below are expected to enhance the revenue opportunities for the indigenous industry especially the private sector.

IAF Programs	Description	Effect on Private Industry
Advanced Medium Combat Aircraft (AMCA)	• The HAL Advanced Medium Combat Aircraft (AMCA) is a program to develop a fifth-generation fighter aircraft. DRDO will be the design agency, and a private industry participant is also expected to be roped in at the early stages of the program. Inclusion of a private industry participant marks a fairly significant shift compared to earlier programs. A total of 4 prototypes are planned, staring with the first flight in 2024-2025.	AMCA is planned to be a joint venture with private sector. The inclusion of private industry at an early stage is a shift from the earlier model where product design and manufacturing was entirely handled by DPSUs. The shift is expected to benefit the entire supply chain constituents who become a part of the program.

IAF Programs	Description	Effect on Private Industry
	• This is the only 5th generation aircraft program in which India is involved since the withdrawal from the Indo-Russian Fifth Generation Fighter Aircraft (FGFA) program.	Further, participation in futuristic programs such as AMCA will increase the domestic industry capability.
Tejas Mk I A Light Combat Aircraft (LCA)	• The Cabinet Committee on Security (CCS) cleared the purchase of 83 LCA MK I A (LCA-Tejas) in a deal worth ₹48,000 crore (approximately $7 billion) from the state-run Hindustan Aeronautics Limited (HAL). This is the biggest-ever contract awarded to HAL or any other DPSU till date. • The order consists of 73 fighters and 10 trainers in the next 5 years. The MK 1 A includes upgrades to the Fire Control Radar, EW system, and overall has 40 modifications over and above LCA MK I. This is in addition to initial order of 40 LCA Tejas MK I that am under delivery.	Private industry players which are a part of Tejas supply chain will also have a higher probability of being a part of future upgrades. For e.g. companies like Apollo Microsystems and Data Patterns are likely to benefit from the program. Data Patterns is in the process of getting its next gen Radar Warning Receiver (RWR) approved which could then become a part of the LCA , and other upgrade programs such as SU-30 MKI
Medium Multi-Role Combat Aircraft Global RFI	• India has also issued an RFI for procuring 110 fighter aircraft, a program which is often dubbed as MMRCA 2. Six global aviation majors having responded to the RFI for the program. • The six firms involved in bidding for the contract are Boeing (F 18 and F 15), Dassault (Rafale), Lockheed Martin (F 21), Saab (Gripen), Eurofighter (Typhoon), and Russia United Aircraft (MiG-35).	• The opportunity impact on Indian private industry will be significant as the program is slated for Make in India. Indigenous companies like Data Patterns, TATA, and L&T are likely to have significant revenue opportunities in the program
LCA Variant	• After the current acquisition of 83 MK 1 a, there are further plans of inducting around 80 LCA Mark II. • The specifications of LCA Mark II have not yet been declared.	• Increased revenue opportunities for the private industry as future variants will have higher indigenous content, and companies

IAF Programs	Description	Effect on Private Industry
		including Data Patterns as mentioned earlier will have a first mover advantage
MiG -29 and SU-30 MKI	• After the face off with China, India declared an emergency purchase of 21 MiG -29 and 12 SU-30 MKI from Russia. The MiG -29 are the existing airframes with Russia and the same will be upgraded to meet the same specifications of the current MiG 29 inventory. The SU-30 MKI order is to augments the loss of aircraft which India has suffered in the past due accidents and incidents.	• Initial impact for private industry will be low; however increased opportunities in future as aircraft fall due for Maintenance Repair and Overhaul (MRO) since it is carried out in India. Future upgrade programs of SU-30MKI will likely involve players from defence electronics such as Paras Defence and Space Ltd and Data Patterns.
Refueller Aircraft	• The latest RFI for 6 tanker aircraft was issued in 2018, with Airbus (A 330 MRTT), Boeing (KC-46), and Ilyushin (IL-78) responding to it. • Not much progress has been made after issuance of the RFI. A lack of funds has been cited as the reason by different sources. The program cost for 6 aircraft is likely to be $2 billion.	Neutral as the deal is likely to be sourced completely from foreign OEMs
AEW&C Aircraft	• The IAF currently operates IL 76 equipped with Phalcon radar and DRDO Netra aircraft, which uses ERJ 145 as the base platform. The total inventory of around 6 aircraft is woefully short of IAF's requirement. • In December 2020, the DRDO was cleared to modify 6 A320 from the national Indian carrier fleet for AEW role. The planned AEW equipment will be an advancement of the existing Netra radar. The program cost is expected to be $1.5 billion.	• • The expansion of AEW aircraft program will benefit a host of supply chain constituents such as Data Patterns which is a supplier of RWR for AEWC on a single vendor basis.

IAF Programs	Description	Effect on Private Industry
Trainer Aircraft	• The IAF is also looking to induct 106 HTT 40 aircraft (to be manufactured by HAL), which is a turbo prop aircraft and is set to supplement the existing Pilatus PC 7 Mk II. • The aircraft has not yet achieved certification, although it is expected to be certified soon. The total acquisition cost is likely to be $1.1 billion. • Fresh acquisition of lead in fighters (current inventory–Hawk) is expected at the end of the decade.	• Indian private industry will benefit from in house manufacture especially the companies dealing in avionics such as Data Patterns and L&T.
Transport Aircraft	• The C 295 program, a joint Tata and Airbus effort, is envisaged to manufacture 56 aircraft in India at a cost of $2 billion. • Additionally, the AN-32 modernisation program will also be a part of the IAF's plans during the period. • The later part of the decade is likely to see an initiation of a new program to acquire medium aircraft for phased replacement of An-32.	• Besides Tata which is the JV partner, supply chain constituents like Dynamatic Technologies (manufacturing) and Data Patterns (electronics) are likely to benefit from the program. in India

Table 3 - Indian Air Force Programmes

IN Programs	Description	Effect on Private Industry
Aircraft Carrier Program	• The refitted and modernised former Russian ICBM Admiral Gorshkov, commissioned as INS Vikramaditya, is the sole aircraft carrier engaged in flying operations with MiG 29K fixed wing fighter. The modernisation has added a new dimension to the capabilities of the Indian	INS Vikrant is the first carrier which has been built indigenously, and has benefited the entire supply chain. The likely commissioning of IAC 2 will have an even higher indigenous component,

IN Programs	Description	Effect on Private Industry
	Navy. • The construction of a 37,500 tonne Indigenous Aircraft Carrier (IAC-1) is underway and set to be commissioned as INS Vikrant. INS Vikrant will have a combination of 30 aircraft, which includes MiG-29K fighters and AEW helicopters (e.g., Kamov Ka-31).	including defence electronics which will benefit the public sector shipbuilding units and private industry like L&T.
Projects 17 & 17A	• Mazgaon Dock Shipbuilders Limited (MDL) has commissioned 4 ships of Project 17 stealth frigates that are capable of carrying 2 advanced multi-role helicopters. • The 7 stealth frigates with advanced features and technology upgrades are a part of the Project 17A programme.	The Indian navy programs have achieved a significant level of indigenisation and manufacturing by DPSUs. This bodes well for the entire defence industry associated with the naval programs
Projects 15A & 15B	• Project 15A involves the construction of additional Delhi-class guided missile destroyers that have stealth and advanced features. • Project 15 B involves similar calls of ships and will be constructed by MDL.	
Project 1135.6-Talwar Class	• INS Tej, Tarkash, and Trikand were commissioned as Talwar Class stealth frigates with the replacement of Klub missiles with the BrahMos system.	
Project 28 ASW Corvettes	• GRSE, Kolkata has indigenously designed and built 4 stealth Anti-Submarine Warfare (ASW) corvettes with minimised radar profiles for stealth capability.	
Carrier Borne Multi	• The 4th generation MiG-29k	Neutral impact as the

IN Programs	Description	Effect on Private Industry
Role Fighters	is now the flagship fighter of the air wing of INS Vikramaditya. Initially, MiG-29K and the naval version of the Tejas were considered for the air wing of the under-construction IAC-1, Vikrant. However, the Indian Navy has begun the search for a Multi-Role Carrier Borne Fighter (MRCBF) for IAC-1. • Global manufacturers have responded to the RFI put out by the Indian Navy, answering questions on technical parameters, level of indigenisation and ToT agreements. Dassault, SAAB, MiG, Boeing, and Lockheed Martin were some of the manufacturers that have been served with the RFI to equip IAC-1, Vikrant, and IAC-2. • The aircraft under consideration are Rafale M, F/A-18 Super Hornet, and MiG-29K are twin jet engines, and Gripen is a single engine option.	deal is slated for direct buying from foreign OEMS
Maritime Patrol and Recon	• Boeing's Poseidon P-8I, Long Range Maritime Reconnaissance and Anti-Submarine Warfare Aircraft (LRMR & ASW) has been inducted. • With an inventory of 12 P-8I aircraft, the Indian Navy is considering the possibility of acquiring 12 additional aircraft. • The gap between surveillance and reconnaissance has been separated into Medium Range Maritime	Neutral impact as the additional acquisitions are likely to be sourced from foreign OEMs

IN Programs	Description	Effect on Private Industry
	Reconnaissance (MRMR) and Short Range Maritime Reconnaissance (SRMR).	
Naval Utility Helicopters	• The Indian Navy is looking at replacing its Chetak helicopters for operation from decks and shore-based support for smaller ships. • Under the Strategic Partnership Model, the procurement of 111 NUH, in a contract worth $3.2billion, was signed by the Defence Acquisitions Council. • An RFP is expected to be issued shortly to OEMs for 16 helicopters in flyaway condition, with the remaining 95 to be manufactured by an Indian manufacturer in a strategic partnership with the OEM. The helicopters considered are: Eurocopter AS565 Panther, Sikorsky S-76B, and a naval version of AgustaWestland AW109 Koala.	This program is slated under the Strategic Partnership model in which a foreign OEM will transfer technology for manufacturing in India. The successful fruition will lead to a significant increase in capability of the indigenous industry; not only the major participants but also the entire supply chain.
Mines Counter Measures Vessels (MCMVs)	• Under the Strategic Partnership model, Goa Shipyard Ltd (GSL) is constructing 8 MCMVs. This could be followed by the construction of similar additional vessels.	• Indian Navy requires at least 24 such vessels for its operational requirement.
Shallow Water ASW Crafts	• Induction of 16 shallow water ASW crafts has been processed, and the ships will be built indigenously.	The Indian defence shipbuilding is undergoing a transformation with a remarkable increase in capability and program fulfilment. Indigenous shipbuilding
Amphibious Capability	• The Indian Navy, to augment its amphibious capability, has inducted the Landing Platform Dock (LPD), with 5 landing ship	

IN Programs	Description	Effect on Private Industry
	tanks and a sealift capability of more than 3,500 troops. • Multi-role landing platform docks are being considered with private shipyards, such as L&T and Reliance Naval and Engineering Ltd., in the running for the contract.	would also increase opportunities in C4ISR systems, heavy engineering, and EW which will benefit companies like Data Patterns, Astra Microwave, L&T, and Paras Defence and Space Ltd
Fleet Support Ships	• The Indian Navy has exercised the option for one follow-on ship offered in the 2008 order for fleet tankers from the Italian shipbuilder Fincantieri. • The government has also approved the induction of 5 fleet support ships.	

Table 4 - Indian Navy Programmes

IA Programs	Description	Effect on Private Industry
Infantry Modernisation	• The Army began the process of acquiring 700,000 rifles, 44,000 LMGs, and 44,600 Carbines in 2017. • An assault rifle built by Ishapore was rejected, as it failed during user trials. A contract was signed by the MoD with Sig Sauer for the purchase of 72,400 SIG 716 assault rifles, of which the Army would receive 66,400 units, the Navy 2,000, and the IAF 4,000. • The AK 203 rifle made by Kalashnikov (Russia) and the OFB (India), a JV, is the main rifle of the Indian Army. They are made at a factory in Amethi. Carbines and the LMGs will also probably build in the same factory.	The army has suffered from critical shortages, and the same is being made good with a mix of foreign and domestic suppliers. The corporatisation of Ordnance Factory Board will have a positive effect on its capability of meeting the requirements with trickledown effect on the supply chain constituents

IA Programs	Description	Effect on Private Industry
	• The OFB has produced a lightweight bullet proof jacket that will be provided to the Indian Army, which has a requirement of 186,000 units. • India and Israel signed a deal for Spike missiles in 2019. The purchase included 12 launchers and 210 missiles that were successful during test fires.	
Network-centric Warfare	• Phase 1 of Shakti Artillery, Combat, Command and Control Systems (ACCCS) is completed, with 40% of artillery units equipped with advanced networks. • Tactical Command Control Communication and Information (Tac C3I) systems and Battlefield Surveillance System (BSS) are in the final test phase. EWS, Electronic Signals Intelligence (ELINT), and Air Defence Control and Reporting System (ADC&RS) are in the process of development. Bharat Electronics Limited (BEL) and the Defense and Research Lab at the Center for AI and Robotics (CAIR) are developing these systems, and it will take 3-to-4 years to for induction of these systems. • The Indian Army also continues to acquire other required elements such as UAVs, weapon locating radars, thermal image intensifiers, night vision systems, and Long Range Reconnaissance and Observation System (LORROS).	• The C3I and Air Defence systems will require a multitude of surveillance and tracking radars which will benefit players like Data Patterns, L&T and , Tata

IA Programs	Description	Effect on Private Industry
Armour, Artillery and Air Defence	• The Armoured Corps and Mechanised Infantry deployed in the mountains need reinforcement. Roads have been upgraded so that the T-72 tank and the BMP-2 can be deployed in Ladakh. There is a need to procure a light tank for mechanised forces. A prototype based on the BAE System Combat Vehicle 90 is being evaluated by the DRDO. • India has a total of 2,011 T-90 tanks armouring 40 regiments; 6 regiments are being raised for high-altitude conditions. • T-72 tanks are being upgraded with night vision devices. The indigenous Arjun tank, heavier than the T-90, has a 120 mm gun that can fire APFSDS, HEAT, High Explosive and HESH and the LAHAT missile, which is a semi active laser homing missile with an 8 km range. • Arjun Mk II is undergoing trials with about 75 modifications. • With 700 BMP-1s in active service, an upgrade is planned for 1,600 BMP-2s with a more powerful 350 HP engine. • In 2019, the 155 mm Dhanush, Howitzer M-777, and the 155 mm self-propelled Vajra were inducted. The long-range Pinaka missile could be inducted in 2022 with user trials underway. • Trials for Precision Guided Munitions are being undertaken for artillery upgrades. The	• A wide range of equipment acquisition programs spanning combat vehicles, tanks, artillery guns, and missiles are being pursued to upgrade the IA operational capability. • The programs would include significant components of electronics, COMINT and SIGINT. • Significant benefits are envisaged for companies like Data Patterns and Astra Microwave which have products in the required categories

IA Programs	Description	Effect on Private Industry
	Hypersonic BrahMos missile is expected to be inducted by 2022. • The Army Air Defence is awaiting the induction of VShorad Igla S-24 missiles. • Development trials for the Quick Reaction Surface-to-Air Missile (QRSAM) have been successful and will be offered for user trials in late 2021.	

Table 5 - Indian Army Programmes

INDIGENOUS INDUSTRY GROWTH DRIVERS

Indian Defence Industry Antecedents

The Indian Defence industry is at an inflexion point, with the increased private sector participation being the way forward.

India's defence industry has come a long way since it embarked on a mission of self-sufficiency in the 1950s. The initial model was designed with enhancing the production of low technology weapons in mind, with production and manufacture being led by Defence Public Sector Units (DPSUs). During the early years, as defence spending and R&D capability was low, major military programmes were executed with help from foreign OEMs. The wars with China and Pakistan in the 1960s catalysed a change in defence policy and increased expenditure in defence procurement. India continued to rely on foreign support; however, the onus shifted towards licensed production – especially of more technologically advanced platforms. In the 1980s and 1990s, the Indian government wanted to bolster self-reliance and embarked on programmes led by the Defence Research Development Organisation (DRDO) such as the Light Combat Aircraft program and the Integrated Guided Missile Development program. A joint venture, which became BrahMos, was also set up between India and Russia to develop and produce advanced cruise missiles. This model of "joint venture led development" was pursued in other ventures such as the Long Range Surface to Air Missile (LRSAM) program, initialised between DRDO and Israel Aerospace Industries (IAI).

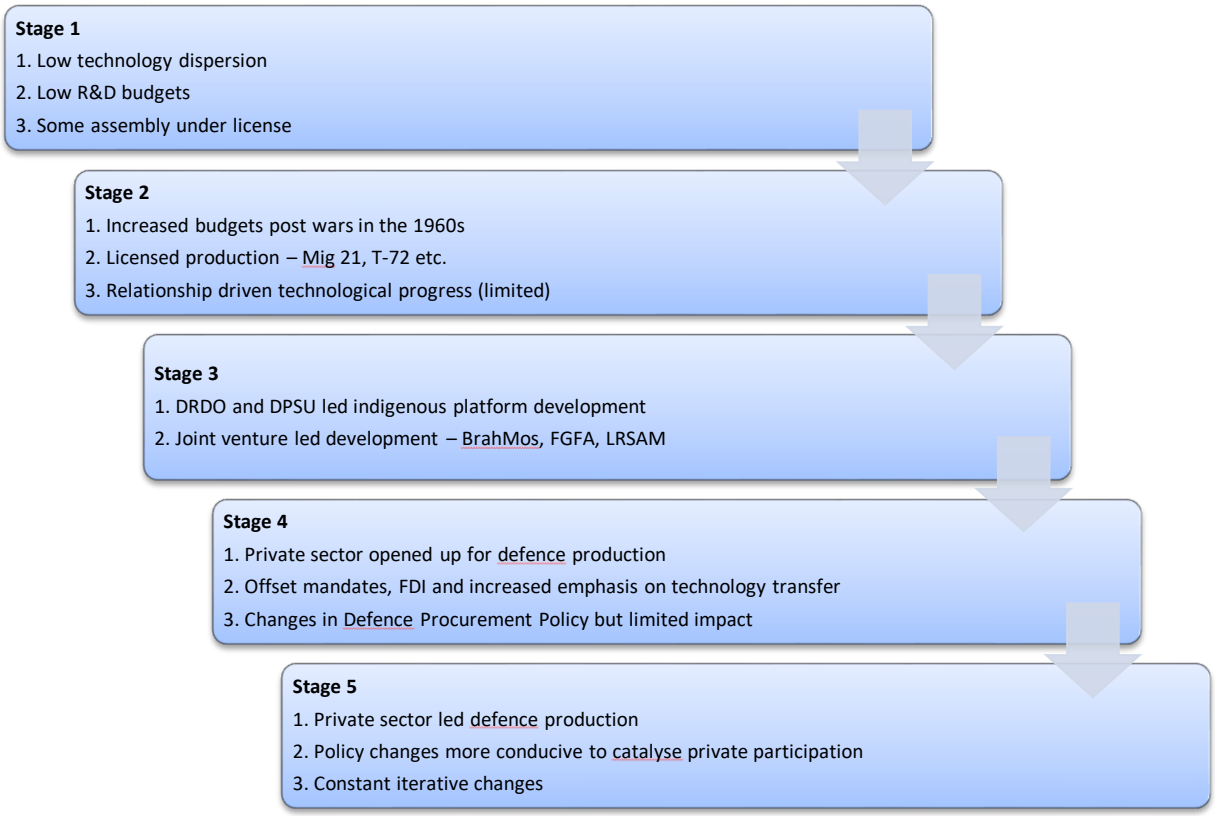


Figure 19 - The Stages of Evolution of the Indian Defence Industry – 1950 to Current

Early 2000 onwards the Indian establishment started shifting its approach to defence modernisation. Projects led by DPSUs faced delays and setbacks and did not achieve the level of indigenisation of components expected by the government. Initially, Foreign Direct Investment (FDI) was viewed as the panacea for a lack of technology dispersion into the Indian defence industry. In 2001, the defence sector was opened up for private investment and offsets were expanded, with freedom given to foreign companies to enter into partnerships of their choice. New procurement categories such as “Buy and Make – Indian” were also introduced to facilitate technology partnerships between foreign and Indian companies. However, no major contracts were executed during this phase because of policy paralysis and the financial terms of engagement were not conducive. The Make in India initiative launched to increase the contribution of the manufacturing sector to the Gross Domestic Product (GDP) by 25% places the onus of development on the private sector. The government has been iteratively improving policy support since then to enable the private defence sector to grow and seize more opportunities. The Indian Defence Minister states that contracts awarded to the Indian industry by the Union Defence Ministry increased from 39.06% in 2015-16 to 75.03% in 2019-20. Similarly,

during the same time frame 158 capital procurement contracts were signed with Indian vendors while only 100 contracts were signed with foreign vendors[48].

At the same time, the private sector has risen to the occasion and providing successful solutions to the Indian military. L&T and Mahindra have evolved into defence primes developing naval[49] and land platforms[50] for the Indian Navy and Army respectively, among other equipment and subsystems. These policy changes also accelerated the development of Indian defence sub primes and component manufacturers.

Meanwhile, several Indian defence subsystem/ component manufacturers had already progressed from supplying components to DPSUs to providing bespoke electronics solutions in the late 1990s itself. These companies expanded their capabilities in the 2000s to provide more advanced solutions including electronic warfare subsystems, microwave transmission equipment etc. In the last five years, several of these companies have started developing full scale solutions such as radars, command and control solutions, intelligence solutions etc. Many of these firms have also expanded their R&D and manufacturing capabilities over the past three years and are currently well positioned to become “partners”, not just “suppliers”, in major defence projects executed by the government or by Indian/ international defence primes.

The evolution of private defence industry has also been aided by the shift of DPSU stance from being present in the entire supply chain to focusing on integration and assembly as shown in the figure below.

[48] https://www.business-standard.com/article/pti-stories/share-of-indian-vendors-in-defence-contracts-grew-over-35-pc-from-2015-16-to-2019-20-govt-120031601152_1.html
[49] https://www.indiatoday.in/india-today-insight/story/lessons-from-project-75-1811982-2021-06-07
[50] https://www.indiatoday.in/india/story/defence-ministry-1300-light-specialist-vehicles-mahindra-defence-1782379-2021-03-22

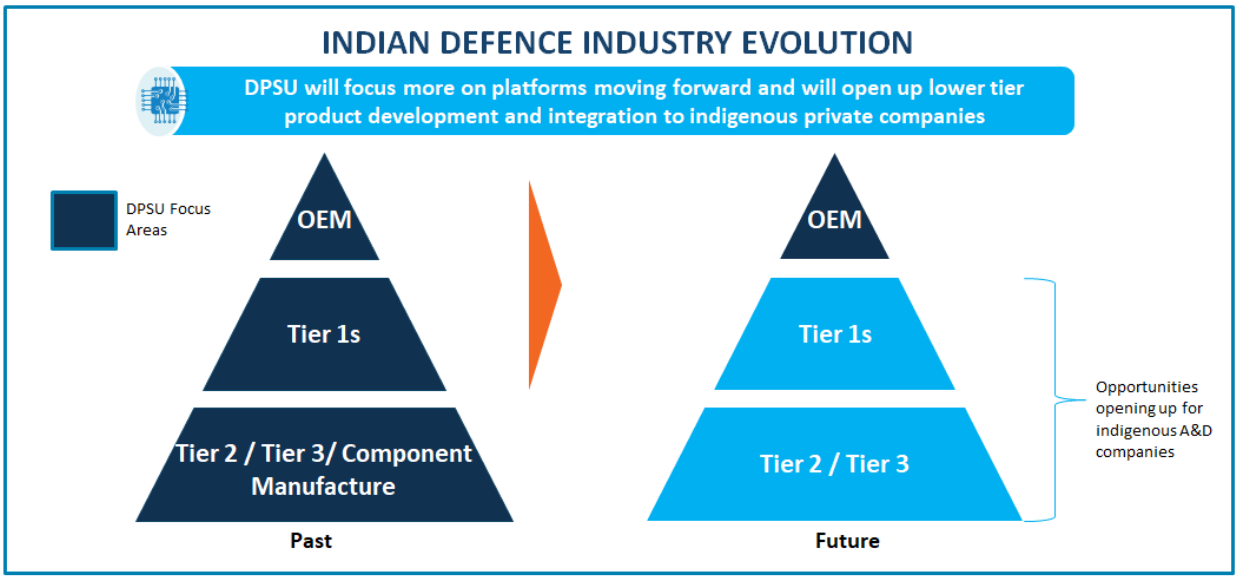


Figure 20: The Indian Defence Industry Evolution – 1950 to Current

Drivers

The government's latest policies seek to build greater self-reliance in Indian defence R&D and manufacturing through a combination of the Aatmanirbhrar Bharat mission, DAP 2020, Offsets and the upcoming Defence Production and Exports Policy

The Indian government's approach to promoting more indigenous industry inclusion has been becoming more calibrated in the last few years. The drivers used are indicated in Figure 21. Whilst the onus has been on increasing prioritisation for Indian company led procurement mechanisms, several other policies have also been initiated to simplify entry into the defence sector, and devolving more freedoms in avenues such as export selection to Indian companies.

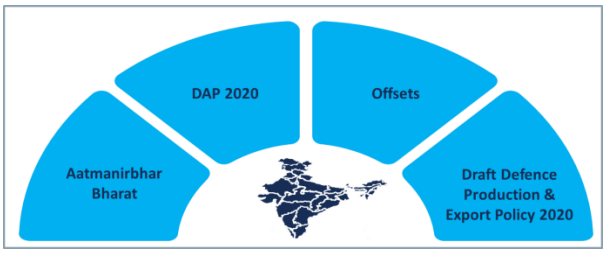


Figure 21- Indigenous Defence Industry Drivers

Aatmanirbhar Bharat

Aatmanirbhar Bharat envisions promoting policies and regulations that leads to self-sustainment in key areas on industry, including defence, through a wide raft of new measures including a Defence Production and Export Policy and import protection. The major measures under the ambit of Aatmanirbhrar Bharat in defence are as follows:

1. Negative Import List – In order to incentivise domestic production and limit imports, the Defence Ministry has banned the import of 209 defence related equipment/ components. Services can only source the listed equipment from Indian vendors. Equipment[51] covered includes segments such as electronic warfare, sensors, radars, Unmanned Aerial Systems etc.

2. Budget Allocations – An outlay of $ 9.48 billion[52] has been earmarked for domestic procurement in FY 2021-2022 in order to mitigate procurement delays stemming from non-availability of capital.

3. Corporatisation of Ordnance Factory Board (OFBs) – The government aims to corporatize OFBs[53] in a bid to improve production efficiency and transparency. There are 41 ordnance factories in India, which source components from Tier 2 and Tier 3 suppliers.

4. Foreign Development Investment (FDI) – The FDI limit under the automatic route has been increased form current 49% to 74%[54]. The increase will encourage foreign manufacturers to invest in India with confidence as they will have a controlling stake in a joint venture.

Defence Acquisition Policy 2020 (DAP 2020)

The DAP 2020[55] focuses on improving indigenous manufacturing by streamlining procurement processes and on introducing "innovation" oriented clauses to further prototype development in India. Other new measures include incentivising foreign OEMs and service providers to set up their own manufacturing/ MRO facilities and a specialised category for "leasing" of equipment which could potentially speed up capability acquisition. A brief of the acquisition categories in the DAP 2020 is presented in the table below.

[51] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/may/doc202153101.pdf
[52] https://www.thehindu.com/news/national/70221-crore-reserved-in-defence-budget-for-domestic-procurement-rajnath-singh/article33901213.ece
[53] https://www.thehindu.com/news/national/ofb-corporatisation-gets-cabinet-approval/article34833105.ece
[54] https://www.thehindubusinessline.com/news/finmin-nod-for-74-fdi-in-defence-sector-under-automatic-route/article33288079.ece#:~:text=The%20Finance%20Ministry%20has%20now,Instruments)%20rules%20for%20this%20purpose.
[55] https://www.mod.gov.in/sites/default/files/DAP2030new_0.pdf

Category	Brief	Benefit to Indigenous Industry
Buy (Indian-IDDM) [Priority 1]	Procurement of products from an Indian vendor that have been indigenously designed developed and manufactured with a minimum of 50% Indigenous Content (IC) on cost basis of the total contract value.	First priority given to Indian vendors with indigenous design.
Buy (Indian) [Priority 2]	Procurement of products from an Indian vendor meeting one of the two conditions: products that have been indigenously designed, developed and manufactured with a minimum of 50% Indigenous Content (IC); Or products, which may not have been designed and developed indigenously but having 60% IC.	Advantage for Indian vendors who may use a foreign design, if they meet the IC requirements on cost.
Buy and Make (Indian) [Priority 3]	Procurement of equipment in Fully Formed (FF) state in quantities as considered necessary, from an Indian vendor engaged in a tie-up with a foreign OEM, followed by indigenous production in a phased manner involving Transfer of Technology (ToT) of critical technologies. This category mandates a minimum of 50% IC in the "Make"component.	Indian vendor remains in lead; incentive for foreign OEMs to have a JV with Indian companies while facilitating Transfer of Technology.
Buy (Global-Manufacture in India) [Priority 4]	Outright purchase of equipment from foreign vendor with a minimum of 50% Indigenous Content (IC) on cost basis of the total contract value which can be achieved in the manufacturing of either the entire equipment or spares/assemblies/sub-assemblies/Maintenance, Repair and Overhaul (MRO) facility for the entire life cycle support of the equipment, through its subsidiary in India.).	Incentive for foreign vendor to facilitate Indian entity for manufacturing; however without ToT.
Buy (Global) [Priority 5]	Purchase of equipment from foreign or Indian vendors. An Indian Vendor participating in this category would be required to meet minimum 30% IC,	Incentive to meet at least 30% IC in equipment which is not being manufactured in

Category	Brief	Benefit to Indigenous Industry
	failing which offset discharge is mandatory. Foreign vendors will also need to discharge offsets in all Buy (Global) cases more than $ 267.88 million other than Single Vendor Cases (SVC) being progressed based on Inter-governmental Agreements (IGAs) including FMS.	India
Strategic Partnership Model	Acquisitions under the Strategic Partnership model refer to participation of private Indian firms and foreign OEM in Make in India in defence and play the role of a System Integrator by building an extensive eco-system comprising development partners, specialised vendors and suppliers, in particular, those from the MSME sector. Strategic Partnerships will seek to enhance indigenous defence manufacturing capabilities through the private sector over and above the existing production base.	Development of Indian defence manufacturing eco-system.
Make and Innovation	This category consists of three Make sub segments – 1. Make 1 (Government Funded) – the government will provide funding to the tune of 70% of the cost for prototype development, capped at ₹ 250 Crore to the developing agency 2. Make 2 (Industry funded) – In this category, any funding for design, development and innovation has to be borne by the Indian vendor. 3. Make 3 – Equipment under this category do not have to be designed and developed in India, but can be manufactured in India – this category is useful for replenishing inventory or for	Funding can be secured for prototyping in case of Make 1, entailing less development risk for the Indian industry stakeholder. Innovation schemes will channel funding to innovative defence and security oriented start-ups and MSME.

Category	Brief	Benefit to Indigenous Industry
	product support. Under the Innovation category, there are three programmes for the procurement of innovative indigenous solutions – • Innovations for Defence Excellence (iDEX)[56] – Projects of low capital investment but high innovation will be pursued from start-ups and MSME under this category. The final product will be procured through the Buy IDDM mechanism. • Technology Development Fund Scheme (TDF) – Projects will be similar to to iDEX but funding will be routed through DRDO[57]. The scheme is envisaged for improving private-public partnership. • Indigenous Development by Services through Internal Organisations[58] – Prototype development will be done by internal R&D agencies of various services. This emulates the internal R&D model pursued by the US which has several capable high technology R&D institutions, such as the Army Research Lab (ARL)[59], working on bespoke requirements of the US Army.	

Table 6 - Capital Acquisition Categories in the Defence Acquisition Policy 2020

The top 3 capital acquisition categories – Buy (IDDM), Buy (Indian) and Buy and Make (Indian) emphasize on Indian company led defence modernisation with a IC

[56] https://idex.gov.in/
[57] https://tdf.drdo.gov.in/
[58] https://www.mod.gov.in/sites/default/files/DAP2030new_0.pdf
[59] https://www.army.mil/arl

category of at least 50%. Moving forward several high value tenders are expected to fall into these categories, giving both private Indian defence primes and subsystem suppliers ample opportunities in increasing revenue and technology base.

Defence Offsets

Though India has extensively pursued defence offsets through an official policy in 2005[60], the earlier policies did not concentrate on technology and R&D capability dispersion from foreign to Indian defence companies. The Defence Acquisition Policy 2020 aims to redress such deficiencies by shifting the focus away from "components" to "technology investments" and "export of platforms"[61]. Avenues for expanding offsets have been expanded in the DAP 2020, giving foreign entities direct credit in transferring critical technologies to the Indian industry. Though certain critical technologies such as hypersonic flight related technology, electromagnetic rail guns etc. has been reserved only for DPSUs and DRDO[62], the vast majority of technologies used in defence equipment are now open to private players.

Another major positive change in India's Offsets policy is the elimination of "offset banking" which foreign companies could use to claim credits on conducting routine business activities in India. The government has tried to balance the interests of foreign stake holders here by allowing them to authorize their vendors to discharge offsets on their behalf. Note that the baseline indigenous component mandates for Buy (IDDM) and Buy (Indian) categories have been increased by 10% to provide more opportunities to the Indian industry. Overall, the new changes aim facilitating technological capability advances of indigenous companies while reserving a greater opportunity share for them in military contracts, accelerating the growth of the Indian defence industry.

Defence Production and Export Policy 2020 (Draft)

The Defence Production and Export Policy[63] is another ambitious step towards Atmanirbhrar Bharat and aims to achieve an industry turnover of $ 25 Billion, including exports of $ 5 Billion by 2025, doubling the size of India's aerospace and defence industry in a timespan of five years. This policy aims focuses on the eight areas listed below:

Focus Area	Brief	Benefit to Indigenous Industry
Procurement Reforms	• Includes reforms such as the already initiated Negative Import Lists	• Greater procurement contracts go to indigenous industry.

[60] https://www.idsa.in/system/files/jds_3_1_tmathew.pdf
[61] https://www.orfonline.org/research/defence-acquisition-procedure-2020-imperatives-for-further-reforms/
[62] https://www.mod.gov.in/sites/default/files/revised-guidelines.pdf
[63] https://www.ddpmod.gov.in/sites/default/files/pdfupload/DraftDPEPP.pdf

Focus Area	Brief	Benefit to Indigenous Industry
	• Taking a project based approach to defence procurement and modernisation. Several developed nations, such as Australia and Canada, that take a project based approach towards defence acquisition, have been successful in time bound modernisation without delays • Overhaul of testing and evaluation procedure and processes to save time • Adopt a "family of weapons" approach and move away from discrete procurement	• Less planning slippages and thus less risk for the industry • Faster acceptance rates, procurement cycle rationalisation
Indigenous Support to MSME and Start Ups	• Intergovernmental mechanisms to promote indigenization • A Defence Investor cell to handhold start-ups and MSME • DPSUs/ OFBs to issue long term contracts for critical items to incentivize indigenous private industry by lowering risk and guaranteeing revenues	Higher value/ long duration contracts from DPSUs/ OFBs can be anticipated to go to the private defence industry
Optimising Resource Allocation	• Setting out a separate budget for domestic procurements. Enhance domestic procurement capital allocations by at least 15% per annum for the next five years • Enhance efficiency and productivity of DPSUs and OFBs	• Greater domestic procurements • DPSUs and OFBs likely to offload ancillary R&D/ subcomponent production to the private sector
Investment Promotion, FDI & Ease of Doing Business	• Focus on the development of an Aero Engines Complex, MRO facilities and investment in critical technologies such as main battle tanks, rocket systems, under water systems, naval systems, communication systems, electro optic systems, EW systems, etc.	• Additional incentives to facilitate expansion of Indian defence companies in Defence Corridors • Indigenous companies can get

Focus Area	Brief	Benefit to Indigenous Industry
	• Provide additional support for Defence Corridors • Continued easing of licensing for defence industries	into new segments rapidly
Innovation and R&D	• DRDO to set up specific "missions" in select areas of hypersonic weapons, armoured vehicles, submarines, airborne sensors etc. • Include production partners at early Technology Readiness Levels (TRL) itself • Competitively funded prototyping • Systems Engineering approach • iDEX for startups	• Indian private companies likely to become major partners of DPSU as opposed to "suppliers" • Involvement at early project stage itself • Funding for prototypes
DPSUs and OFB	• Position DPSUs as system integrators and create a multi-tier domestic supply chain • Corporatization of DPSUs/OFBs • Maximise outsourcing from indigenous sources • Disinvestment and technological upgradation	• More opportunities to the Indian defence industry as DPSUs offload subsystem/ subcomponent production to private players
Quality Assurance & Testing Infrastructure	• Streamlining of processes and made time-bound • Accredited third party inspection bodies to augment DGQA in quality control • Government testing and quality control infrastructure to be expanded and made easily available to private players • Assistance provided to industry to set up testing facilities • Expanding self-certification in certain cases	• Greater opportunities and revenues in the resting and QA sector for the private defence industry • Products can be made market-ready more rapidly • Lesser wait times for private defence companies that want to use government testing

Focus Area	Brief	Benefit to Indigenous Industry
		facilities
Export Promotion	• India aims to add $5 Billion in defence exports by 2025 • Open General Export License regime • Defence Attachés to promote Indian defence industry • Export clearance processes to be made time-bound and hassle free	• Faster export license approvals • Attaché support for export promotion

Table 7 - Features of the Draft Defence Production and Export Policy 2020

Rising Defence Exports

The Indian defence exports are likely to grow at a fast rate due easing of export restrictions and policy changes. This is also being compounded by rising prowess of the Indian defence suppliers. The Indian defence exports are now dominated by the private sector as compared to defence public sector units, and are expected to drive revenue opportunities Companies in niche products such as Data Patterns are well positioned to capture the growth in exports

India continues to be the among the top 5 importers of armed equipment in the period 2016-2020 as per SIPRI report; "Trends in International Arms Transfer" released in 2021[64]. However, it is heartening to note that its share of the global arm imports dropped from 14% in 2011-2015 to 9% in 2016-2020, a drop of 33%. This is a clear indicator of the fruition of efforts to promote the capability and sourcing from domestic defence industry.

While India continues to remain a net importer, the country also figured in the top 25 exporters in the same list for the first time in 2019. India was ranked as # 23 in 2019, and # 24 in 2020 (the drop is attributable to manufacturing disruptions due a stringent lockdown) in the overall list of arms exporters. The share of India in global defence exports was pegged at 0.2% for the period of CY2016-2020 as compared to 0.1 % in the period CY 2011-2015; up by 288%[65].

The defence exports from FY 2014-15 to FY 2020-21 are shown below[66]:

[64] https://www.sipri.org/sites/default/files/2021-03/fs_2103_at_2020_v2.pdf . All SIPRI data is represented in CY

[65] Percentage increase does not match due rounding off the global share in exports

[66] https://www.mod.gov.in/sites/default/files/MoD2RE7621.pdf

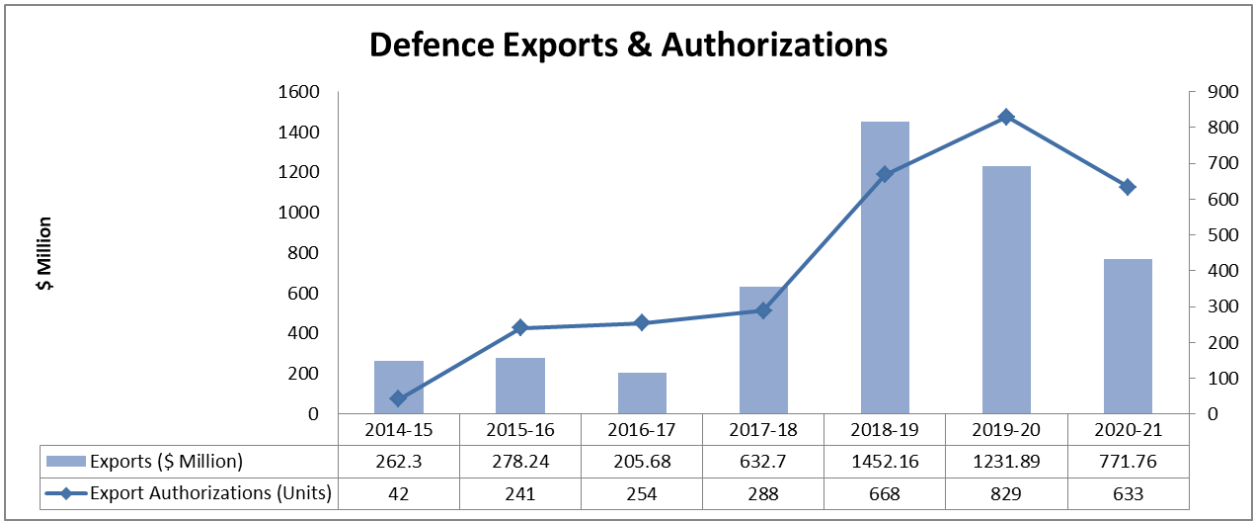


Figure 22 Indian Defence Export Growth

Indian defence exports crossed the $ 1 billion mark in 2018-2019. There was a dip in the exports in 2020-2021 largely attributable to supply chain and manufacturing disruptions which have eased now.

A few years back, India's export customers were only small economies such as Seychelles, Suriname, Myanmar, Sri Lanka etc. Now, exports stand more diversified both in terms of product and their markets. Recent exports include the following-

- Helmets, bomb suppression blankets, soft armour panels and cartridges to Germany.
- Night vision devices to Finland.
- Mine protected vehicles, over-vests, helmets, soft armour panels and civil helicopter protection equipment to the United Arab Emirates (UAE).
- Export of radar components to Singapore.
- Weapon locating radar systems to Armenia.
- In September 2017, India secured a military export order for $ 21.07 million for 40,000 pieces of components for artillery guns from the Government of the United Arab Emirates.
- The Garden Reach Shipbuilders & Engineers Limited (GSRE) sold India's first indigenously made warship, the Barracuda, to Mauritius for 58.5 million.
- India has sold indigenously developed lightweight torpedoes to Myanmar and Vietnam.
- Avionics have been exported to Malaysia for the Sukhoi Su-30MKM.

- One Fast Patrol Vessel and 11 Fast Interceptor boats were exported to Mauritius.
- Three HMS-X2 Sonars were exported to Myanmar in 2015.

Note that majority of the exports today are being driven by the private sector and the government is creating enablers for Indian companies to further improve exports. With further liberalisation of export license, and increasing capability, the prospect of Indian defence exports looks bright. Globally, there is a drive to reduce the cost of defence equipment produced, and Western defence majors are increasingly looking at Indian companies, especially those with competencies in defence electronics and ancillary technologies, for potential partnerships. More Indian Tier 2 and Tier 3 defence companies will have opportunities to embed themselves into global defence supply chains moving forward.

The jump in exports can be attributed to modifications of export policy made in order to make it easier for companies to get export licenses. The department of defence has further issued guidelines on strategy for exports which aims to facilitate the vision of exporting $ 5 billion by 2025[67]. The major initiatives of the export strategy[68] are as exhibited in Table 9 below:

Initiative	Brief
Establish Export Promotion Body	A specific export promotion/ facilitation body with participation from industry representatives. The role of the body would be to (i) Render advice to government on various export related issues (ii) Coordinate all export facilitation schemes of the government (iii) Increase awareness amongst the industry about various export facilitation measures (iv) Promote exports through specific marketing efforts in targeted countries (v) Facilitate national and international trade shows

[67] https://timesofindia.indiatimes.com/india/aim-to-achieve-25-billion-in-defence-production-and-5-billion-exports-by-2025-rajnath-singh/articleshow/80705233.cms#:~:text=Aim%20to%20achieve%20%2425%20billion,India%20News%20%2D%20Times%20of%20India

[68] https://www.ddpmod.gov.in/sites/default/files/STRATEGY%20FOR%20DEFENCE%20EXPORTS.pdf

Defence Export Steering Committee	Steering committee under the Chairmanship of Secretary, Department of Defence Production with representatives of Armed Forces, DRDO, PIC Wing, Acquisition Wing, MEA, and DGFT. The functions would be to (i) Take decisions on cases of export permissions, which are outside the purview or scope of subordinate authorities/committees particularly export of indigenously developed sensitive defence equipments, (ii) Monitor the progress in defence exports and suggest specific steps/ strategy to boost exports
Defence Diplomacy	(i) Industry delegations from public/ private sector/ JVs of private and public sector would be included in bilateral meetings/ discussions with various countries so that the importing country gets due comfort while importing from India (ii) Industry delegations would be taken to target countries under the leadership of officials or DPSUs representatives (iii) Indian Embassies/ Missions abroad would be associated in making targeted efforts for promoting export of Indian defence products.
Export Financing	(i) Line of credit facility available in Ministry of External Affairs would be leveraged suitably to promote defence exports from India. (ii) Possibilities for financing of defence exports through EXIM Bank. (iii) Buyer's Credit facility of Department of Commerce would also be leveraged. (iv) Separate strategy to finance the exports to weaker countries would be worked out in consultation with MEA, EXIM Bank, DPSUs, private sector and other financial institutions.
Use of Offset Policy	(i) Offset Policy to be reviewed and aligned towards final integration of weapons/systems in India and promoting export of such systems from India (ii) Policy to be reoriented towards acquisition of critical technologies required for high end weapons/platforms so

	that the same can be leveraged for export
Issue of NOC	Revision of policy to issue NOC and End User Clearance certificates including provision of 'in principle' clearance to the industry, so that it can explore export opportunities
Online and Time Bound Clearance	A web based system to be developed to receive applications for NOC online and convey the NOC to the companies
Export of Indigenously Developed Sensitive Systems	Defence Export Steering Committee will take appropriate decisions regarding exportability of item with/ without modification or degradation.

Table 8 - Department of Defence Production Strategy for Exports

GLOBAL & DEFENCE ELECTRONICS MARKET

Global Defence Electronics Market

At present there are over 150 active conflicts ongoing in different regions primarily over the last decade. This has meant that the complexity and diversity of the conflict has evolved, forcing armed forces across the globe to revisit their force structure, concept of operations and invest in evolving technologies. As operators are exploring hybrid warfare and multi domain operations, increasing investment in defence electronics will ramp up towards the later part of the decade.

Defence electronics will have to evolve to enable more complex and dynamic operations that provide operators with force multiplier capabilities. Globally defence electronics procurement is going to become a core component for defence procurement as the amount of electronics that are fitted onto platforms continues to grow. Over the last decade the defence electronics component has consumed a larger share of the value of the platforms overall value as defence capabilities evolution continues through evolution of the electronics systems and embedded software rather than the platform itself. Aircrafts have seen a large adoption of new optronics systems, communication systems and battle management systems that exploit the new multi domain concept of operations. Naval platforms have been increasingly adopting new electronic warfare, radar, command and control systems

as platforms have been required to undertake muti-role operations. The increase in defence electronics spending is a symptom of a wider shift in battle engagement philosophy from combat mass – where having numerical superiority was key towards a smaller number of highly capable platforms supported by sophisticated defence electronics systems.

The following technology areas will have significant impact on the defence electronics market and dictate demand:

1. Machine Learning and AI
2. Software Defined Systems
3. Open Architectures
4. Convergence of RF systems
5. Edge Computing

Platform recapitalisation will drive the global defence electronics market for the immediate future. New platform procurements such as the Next generation future air combat systems (FCAS and Tempest) will see an increase in the number of defence electronics content used compared to legacy platforms. Upgrades to existing aircraft fleets, with the use of new AESA radars, electronic warfare, ISR systems. Naval and land systems are also experiencing higher investment in defense electronics, with renewed focus on electronic warfare, self-protection systems, etc.

Programme	Time-Frame	Description
F-35 Program	2015-2044	The Lockheed Martin F-35 Lightning II is an American family of single-seat, single-engine, and all-weather stealth multirole combat aircraft to provide electronic warfare and intelligence, surveillance, and reconnaissance capabilities. The U.S. plans to buy 2,456 F-35s through 2044 and is projected to operate until 2070
Next-Generation Combat Vehicle (NGCV)	2017-2035	The Next-Generation Combat Vehicle (NGCV) is intended to procure a variety of armored vehicles to replace existing platforms that are nearing the end of their service life. The program covers the following systems: Replacement for the M2 Bradley IFV. Replacement for the M113. A light tank for Infantry Brigade Combat Teams (IBCTs). Three unmanned ground vehicles in light, medium,

Programme	Time-Frame	Description
		and heavy configurations. Replacement for the M1 Abrams main battle tank.
Type 26 frigate	2020-2050	The programme, known as the Global Combat Ship, was launched by the UK Ministry of Defence to partially replace the navy's thirteen Type 23 frigates, and for export. A total of 32 are planned to be built for UK, Australia and Canada.
Main Ground Combat Systems (MGCS)	2020-2027	The Main Ground Combat System (MGCS) is a project by France and Germany since 2012 to replace their currently deployed Leclerc and Leopard 2 main battle tanks (MBTs). The program is expected to contribute towards continued growth towards the end of the decade as the programs transition to production contracts.
Pegasus Program	2021-2025	Germany had plans to acquire four Northrop Grumman MQ-4C Triton UAVs configured for signals intelligence (SIGINT)) at an estimated cost of $2.5 billion. Instead, it has decided to acquire new strategic airborne signals intelligence (SIGINT) capability based on a fleet of modified Bombardier Global 6000 business jets.

Table 9 - Brief Overview of Global Defence programs

As platforms have become more complex, the defence electronics component of the platform acquisition cost is expected to rise from 30% to 45%. As such the global defence electronics market was worth ~ $ 550 billion from 2016-2020 growing at a CAGR of 4.1% during the period, and is expected to be worth ~$ 1.74 trillion from 2021-2030 with a CAGR of 6.2%.

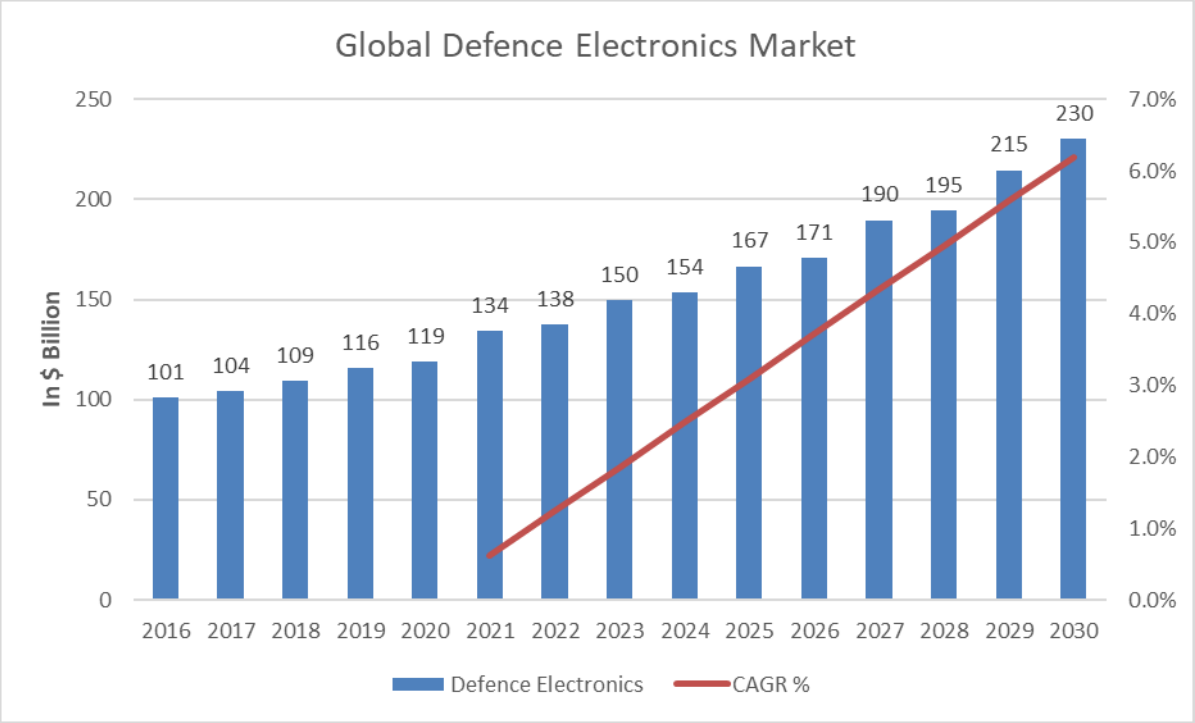


Figure 23 - Global Defence Electronics Market

Note: 2016-2020 is the actual market size. 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during 2021-2030.

Indian Defence Electronics Market
Defence Electronics

The Indian Defence Electronics segment will witness large scale indigenization efforts over the next decade leading to improved manufacturing and quality standards. This will further increase the presence of Indian components in global supply chains which are already being used in Israeli UAS and European combat aircrafts. At present Defence Electronics make up only 25-35% of the cost of platforms used by the Indian armed forces, which is expected to increase in the future. However, at present over 60% of the electronic components used are supplied by foreign OEM's. As indigenisation efforts continue, future procurement will see a large portion of defence electronics sourced locally, and as such platform recapitalization programmes across all three forces such as new combat aircraft acquisition, submarine building and T-72 replacement will be key contributors to future market valuation of this product segment.

The Defence Electronics market was cumulatively worth ~ $ 8.09 billion from 2016-2020 and grew at a CAGR of 4.5% during the period[69]. At present the market is

[69] **Note: All forecasts and past estimates have been calculated for CY The years mentioned in the write uo in this section also pertains to CY.**

evaluated to be worth approximately ~ $ 1.88 billion in 2021[70] and is expected to grow to ~ $ 6.99 billion in 2030 with a cumulative market opportunity for this segment in the order of ~ $ 43.98 billion and a CAGR of 15.71% during the period.

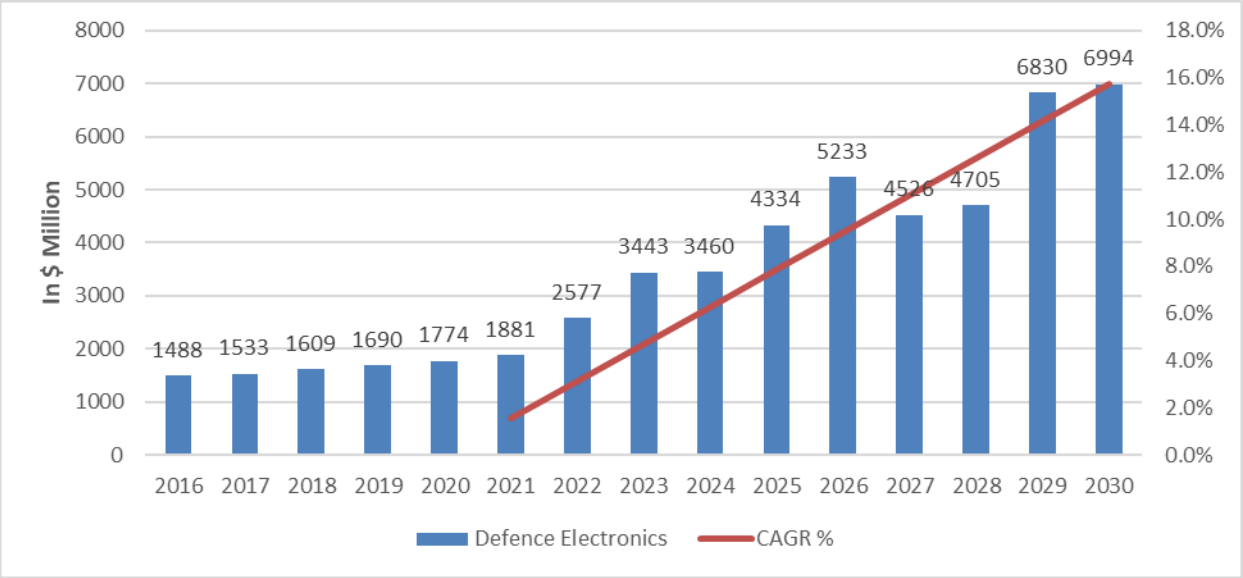


Figure 24 - India Defence Electronics Market

Note: Figures for CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

The segment will exhibit growth until 2026, driven mainly by the programmes listed:

Program Name	Defence Electronics Opportunities
UAS procurement by the IAF	$ 1.43 billion
Rotary Wing Procurement by the IAF and Indian Navy	$ 1.88 billion
IFV/ APC Procurements by the Indian Army	$ 3.61 billion
Command and Control/ Tactical Communications Modernization	$ 5.09 billion

[70] The Indian defence budget was discussed in FY; however these projections are for calendar year. There is no significant difference between the two values as a time difference of a quarter is inconsequential due to the length nature of acquisition cycle

Combat Aircraft Procurement by the IAF and Indian Navy	$ 7.9 billion

Table 10 – Programs Driving Indian Defence Electronics Market

As programmes come to a conclusion such as UAS, Naval Helicopters and transport aircraft and upgrade programmes for Offshore Patrol Vessels, a dip in the projection is expected in the 2027-2028 timeframe. However, an immediate rebound is expected as modernization requirements for IAF's ISR and Combat aircraft and extensive C3 and tactical communication-oriented modernization get underway.

EMP Protection

The EMP Protection market was cumulatively worth ~ $ 2.21 billion from 2016-2020 and grew at a CAGR of 5.5% during the period. The EMP Protection segment will grow from ~ $ 513 million in 2021 to ~ $ 4.3 billion in 2030 at a CAGR of 26.6% during the period. The total market valuation for EMP Protection equipment during this time frame is forecasted to be $ 27.8 billion.

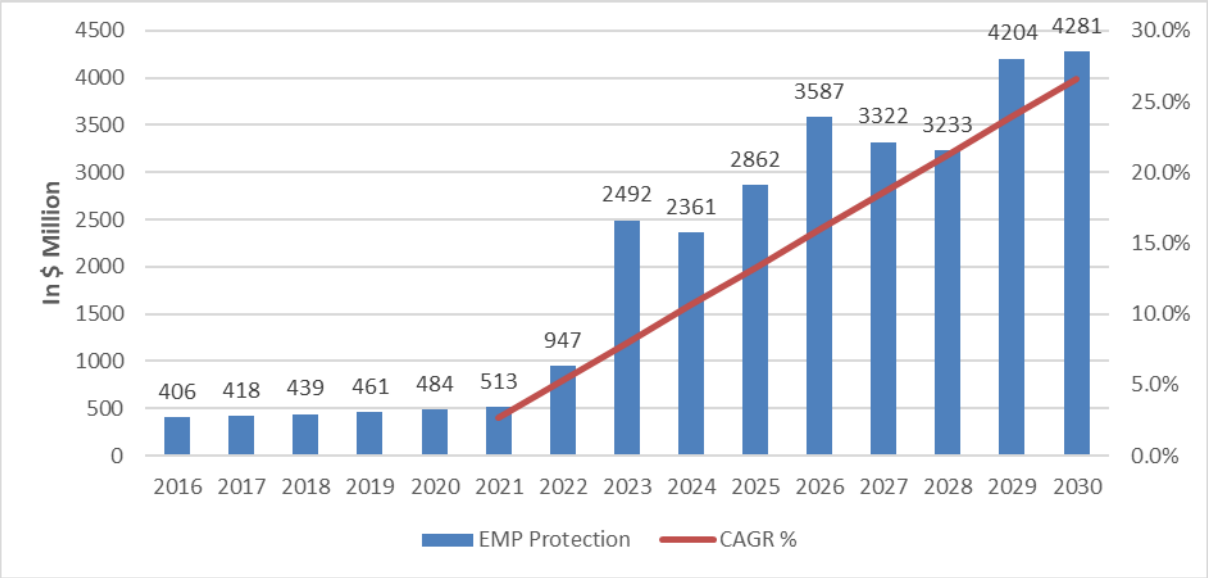


Figure 25 - India EMP Protection Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

As greater emphasis is placed on hardening of forward Command and Control infrastructure bases and platforms from Chinese attacks, EMP protection will be more closely integrated in future platform designs resulting in greater investment in the segment.

Defence Optics

The Defence Optics market was cumulatively worth ~ $ 1.09 billion from 2016-2020 and grew at a CAGR of 4.5% during the period. The Defence Optics market will be driven by major procurement of airborne combat and ISR capability requirements along with land forces modernization. The Naval contribution to this segment will be limited in comparison to the Air Forces and Land Forces. The market is expected to be worth approximately ~ $ 255 million in 2021 and grow to ~ $ 2.1 billion in 2030 with a cumulative opportunity of ~ $11.49 billion at a CAGR of 26.5%.

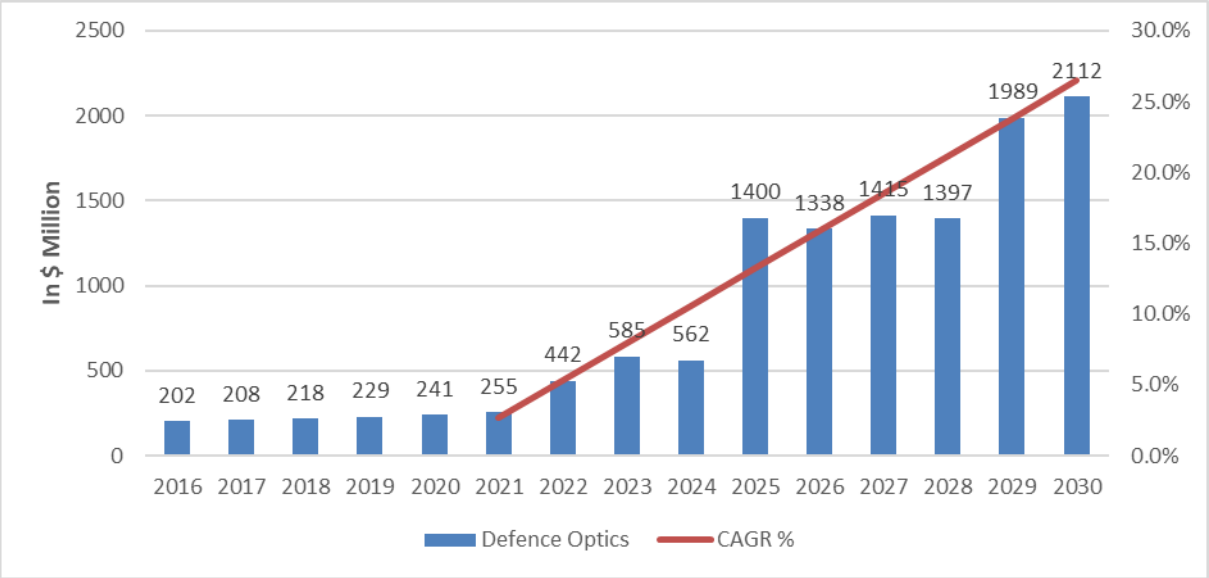


Figure 26 - India Defence Optics Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

New procurement of electro optic payloads for the Navy's future Multi Role Helicopters, targeting systems for next generation combat aircraft for the IAF and night fighting capability for the older BMP-2 and new IFV's will drive a surge in the defence optics market. A further acquisition spree is expected in 2028 as several platforms in the IAF especially ISR ones ill need to have mid-life upgrades. Similar mid-life upgrades are expected for the Navy's patrol vessel fleets and MBT's of the Indian Army, requiring new imaging equipment.

Military Radar Market

The military radar r market was cumulatively worth ~ $ 5.02 billion from 2016-2020 and grew at a CAGR of 7% during the period. The Radar market is estimated to be worth approximately ~ $ 1.25 billion in 2021 made up of radars for ground, naval and radars for airfield. India has approximately 14.5 thousand kilometres of land borders to monitor of which approximately seven thousand kilometres is critical. With a naval

fleet size of 133 platforms, they represent a significant opportunity for radar modernization and upgrades in the future. The market is expected to grow to ~ $ 3.18 billion in 2030 with a CAGR of 10.9% and a total market opportunity of ~ $ 20.59 billion.

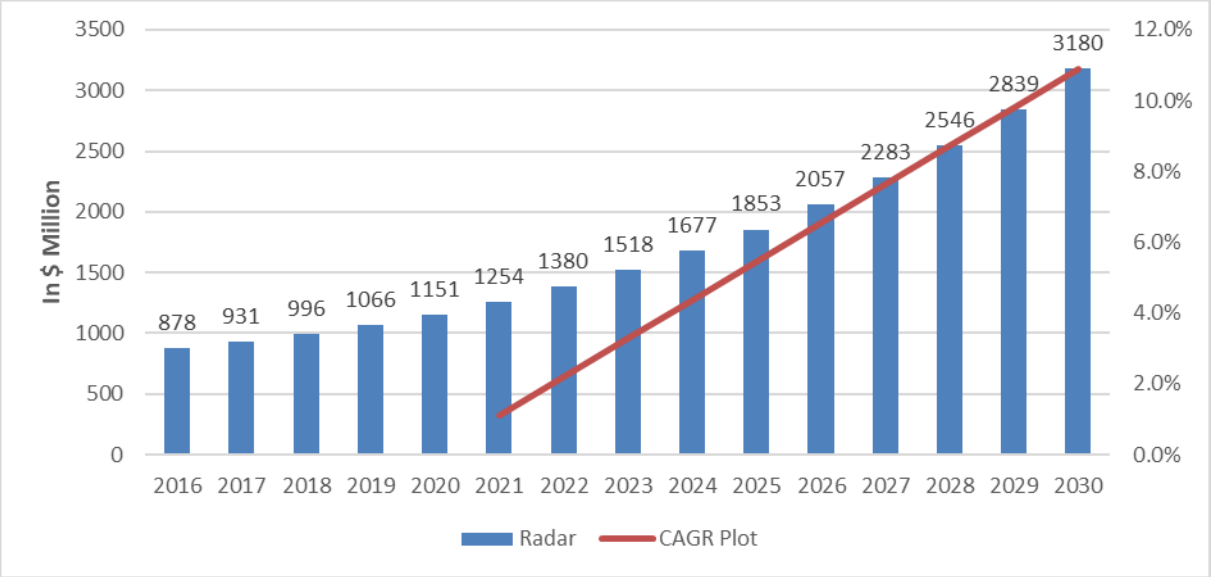


Figure 27 - Military Radar Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

New procurements for precision approach radars are expected to modernise airfield, with radars older than 20 years expected to be gradually phased out over the next decade. Data Patterns already having sold Precision approach radars, wind profile radars and Doppler weather radars to the Indian government has positioned themselves for success for future programs in the next decade having the technological and delivery capability for success. Data Patterns won the Array Group Receiver Unit (AGRU) as part of the Arudhra - Medium Power Radar program. Data Patterns will supply ~ 55 units of AGRU/ Arudhra radar. RFP for 18 Ashwini - Low Level Transportable Radar (LLTR) are expected from Air Force next year. The 18 radars are expected to cost around ~ $ 270 million, with IA has requesting budgetary quotes from Data Patterns, Astra Microwave and BEL. The development of new-generation missiles with high-end technologies is a major threat to strategic locations and platforms, such as military airbases and ships. Some of these new developments include nuclear-capable ballistic missiles and high-speed cruise missiles. New radar procurements will be required to counter evolving threats and thus have features such as multiple-bands, AESA radars, etc. Naval vessel upgrades such as the Talwar-class frigates, procurement of additional Shivalik-class frigates and replacement of the Godavari-class will drive radar procurements. Data Patterns has delivered airborne surveillance radar (all of the hardware) for

helicopters and fixed wing aircrafts to LRDE on a single vendor basis. LRDE is expected to flight test this radar in the next few months. This will be offered for Navy's Dornier upgrade and as buyer nominated equipment for the new helicopter programs.

Airborne EW

The Airborne EW was cumulatively worth ~ $ 1.8 billion from 2016-2020 and grew at a CAGR of 7% during the period. The Airborne EW market is expected to be worth ~ $ 378 million in 2021 and grow to ~ $ 606 million in 2030 at a CAGR of 5.4% driven by modernization of platforms such as the IAF's requirement for 200+ single engine fighters, acquisition of the HAL Tejas, Dassault Rafale, procurement of A330's and C-295 and future procurement of the HAL AMCA. Modernization of existing platforms will also contribute towards this market evaluation. Indian companies that have existing RWR, COMINT, ELINT and EW systems like Data Patterns are well positioned to capture the opportunity having already built systems in partnership with DRDO. For e.g., Data Patterns' next gen RWR meets the requirements for the LCA MK IA and is under testing.

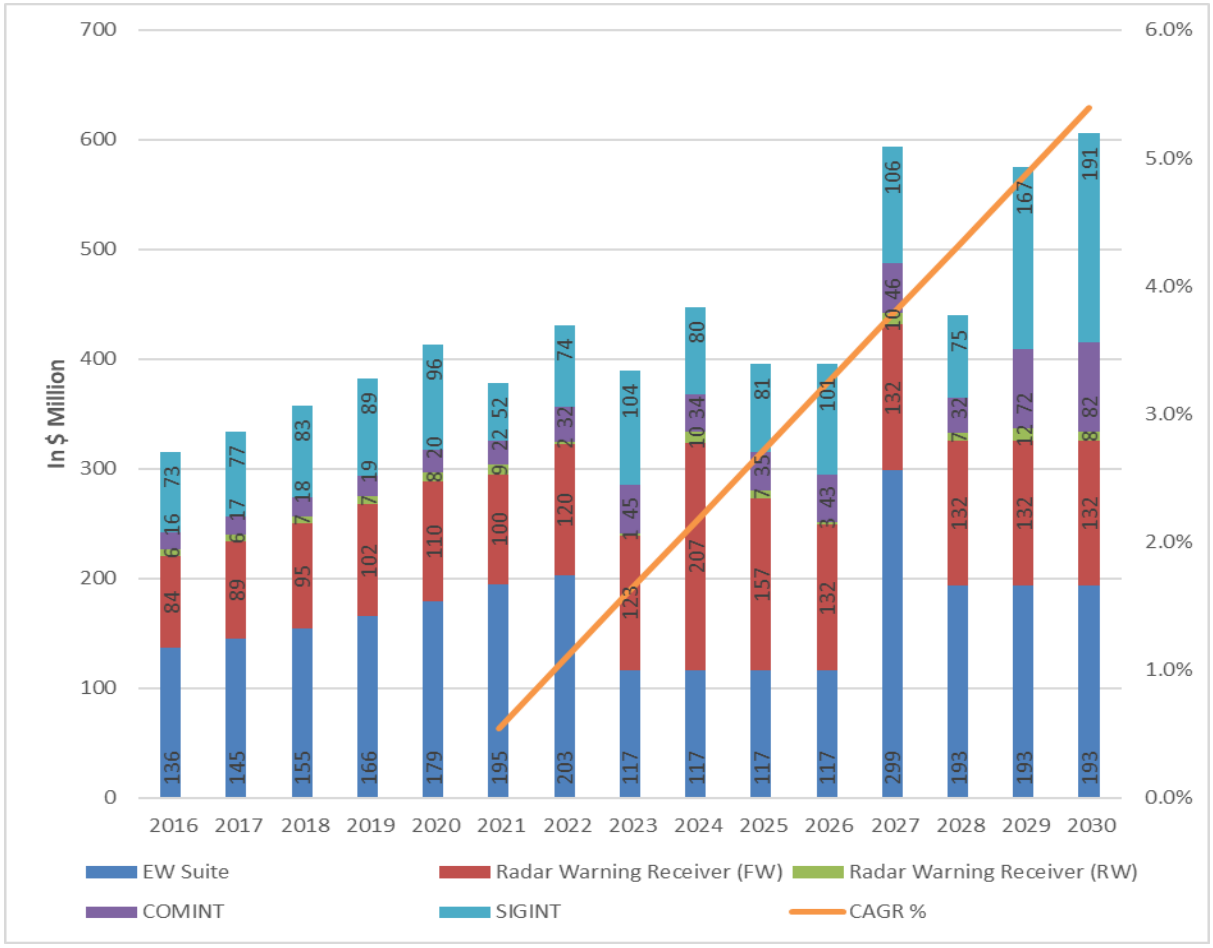


Figure 28- India Airborne EW Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

With an increased focus on EW systems, they are undergoing a modernization phase due to the emergence of Next Generation Jammers and AESA that is being explored for EW equipment. These technologies allow generating complex jamming waveforms, in addition to being modular to be installed on platforms as per the operational requirements. There is also a shift towards integrated EW solutions with advanced signal processing and miniaturisation with complex and powerful digital wideband receivers that are able to instantaneously process GHz of signals in complex spectrum environments. The market will also be drive by an increasing need for a distributed, adaptable network Electronic warfare capability to facilitate the integration of several EW technologies on both manned and unmanned aircrafts. This will enable a complete horizontal integration of multiple payloads, leading to increased situational awareness.

Torpedoes

The Indian Defence Electronics market for torpedoes is primarily being driven by replenishment of existing arsenals and procurement of new naval platforms such as:

Program Name	Torpedo Opportunities
Arihant – Class submarine	A total of four submarines planned in two flights.
S5 – Class	3 planned. Expected to start production by 2022.
Project 75 Alpha	The Indian Navy aims to procure new nuclear-powered attack submarines (SSN). The construction is expected to commence on 2023-24 while the first submarine is expected to enter service in 2032.
INS Vishal	INS Vishal as a replacement of the INS Vikramaditya
Varunastra - Torpedo	Advanced heavyweight anti-submarine torpedo, developed by DRDO for the Indian Navy. In June 2019, Ministry of Defence awarded a contract worth ₹1,187 crore

	(US$170 million) to Bharat Dynamics Limited to supply Varunastra to the Indian Navy with plans for 73 of them.

Table 11 – Programs Driving Torpedoes Sensor Market

The Torpedo component market was cumulatively worth ~ $ 63.81 million from 2016-2020 and grew at a CAGR of 7.5% during the period. The market for seekers for torpedoes is expected to be worth ~ $ 16 million in 2021 and grow to ~ $ 41 million in 2030 with a CAGR of 10.89%. The stable growth is since the number of torpedoes in service is expected to be the same, increasing only as the number of naval platforms as described above increases. Moreover, about 5% of the torpedo stock is expected to undergo replenishment every year.

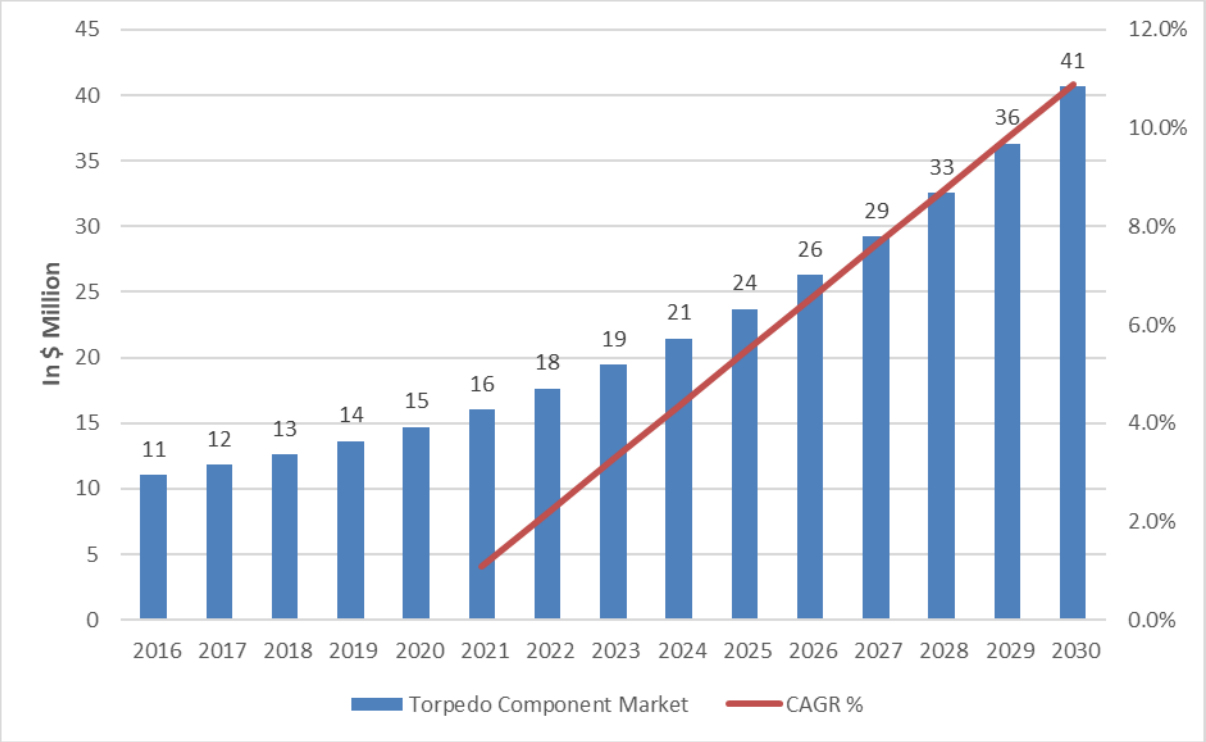


Figure 29 - Torpedoes Component Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

Military Avionics

The Defence electronics avionics market is dictated by the frequency of modernization and replacement of existing platforms in addition to procurement of new combat capabilities. The market will be driven by procurement of avionics for the following platforms:

Program Name	Avionics Opportunities
HAL Tejas Mark1/Mark 1A	HAL has already received orders for 40 aircraft of Mark 1 variant which will be delivered by 2022. In 2021 the Ministry of ordered 83 advanced Tejas with advanced AESA Radar, Jammers, superior avionics, next-gen BVR missiles, better payload, and enhanced combat range. The induction will be completed by 2028. Data Patterns has supplied the Smart Standby Display Units (Cockpit Displays) which will be procured for this program.
MMRCA 2.0	An RFI was issued by India in April 2018 for the procurement of 114 multi-role combat aircraft for the Indian Air Force.
C295	56 C-295 transport aircraft under the Make-in-India initiative. The program is at financial approval stage and the contract is likely to be signed in the near future. The first 16 planes will be supplied in two years, with the rest spread over the next eight years.
HAL Light Utility Helicopter	On March 2021 Ministry of defense placed an initial order of 6 light utility helicopters for the Indian Airforce. The deliveries are expected to commence from Aug 2022. The Glass cockpit and Digital Interface units are designed and developed by Data Patterns. Based on around 180 LUH planned, contracts of Rs 2500 to 3000 million is likely for these of these are required for around 180 LUH planned. The number of LUH is likely to go up due the delay in finalising the Kamov 226 program.

Table 12 - Programs Driving Military Avionics market

The military avionics market was cumulatively worth ~ $ 1.27 billion from 2016-2020 and grew at a CAGR of 8.8% during the period. The Avionics market is expected to be worth approximately ~ $ 315 million in 2021 and is expected to grow to approximately ~ $ 454 million in 2030 at a CAGR of 4.2% over the decade. New aircraft procurements as highlighted above will be a major driving force for new avionics with modern capabilities. Companies that can develop the entire range of avionics required for both fighter aircrafts and helicopters will find ample opportunities as India looks to procure the HAL LUH and LCA MK 1A.

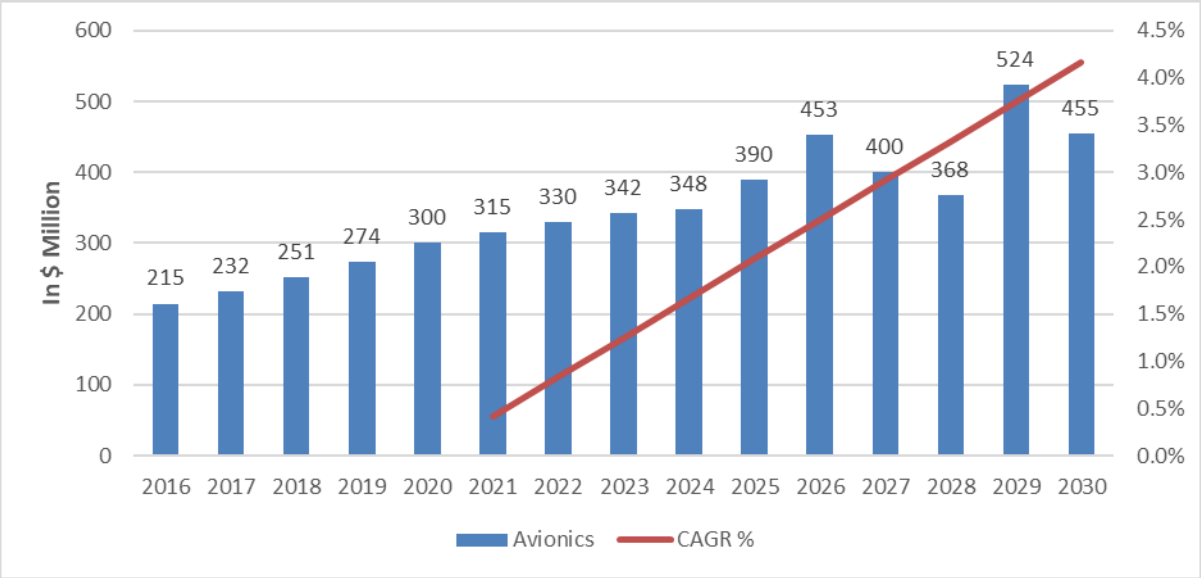


Figure 30 India Defence Avionics Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

Land COMINT/ELINT

The ground based COMINT/ELINT market will be driven by modernization of existing mechanised infantry battalions with dual purpose units performing COMINT/ELINT roles as well as dedicated platforms. There are dedicated platforms that are operated that were developed as part of programme Divya Drishti. Other platforms that are dedicated to this task are the Samyukta Electronic warfare system, the Himashakti SIGINT platform and the Himraj ground based ELINT solution. At present the penetration of COMINT/ELINT capability is limited but is expected to increase in the future with the launch of program Dharashakti. Data Patterns has received single vendor orders from DLRL for development and supply of all of the COMINT search receivers, Direction Finder, Monitoring receivers, etc. for the Dharashakti program. There is also a requirement for ELINT receiver as part of development program for S&S which is a large EW requirement for Deserts and Plains nominated to BEL.

Furthermore, a new program for EW for Mountains has been initiated in DRDO as a precursor to Army requirements. These programs would drive the ground COMINT/ELINT market. Data Patterns is well positioned for the Himashakti and Dharashakti program in the market having previously sold COMINT receivers to BEL /ECIL for Samyukta upgrade, Himraj, etc. to final delivery to the Indian Army.

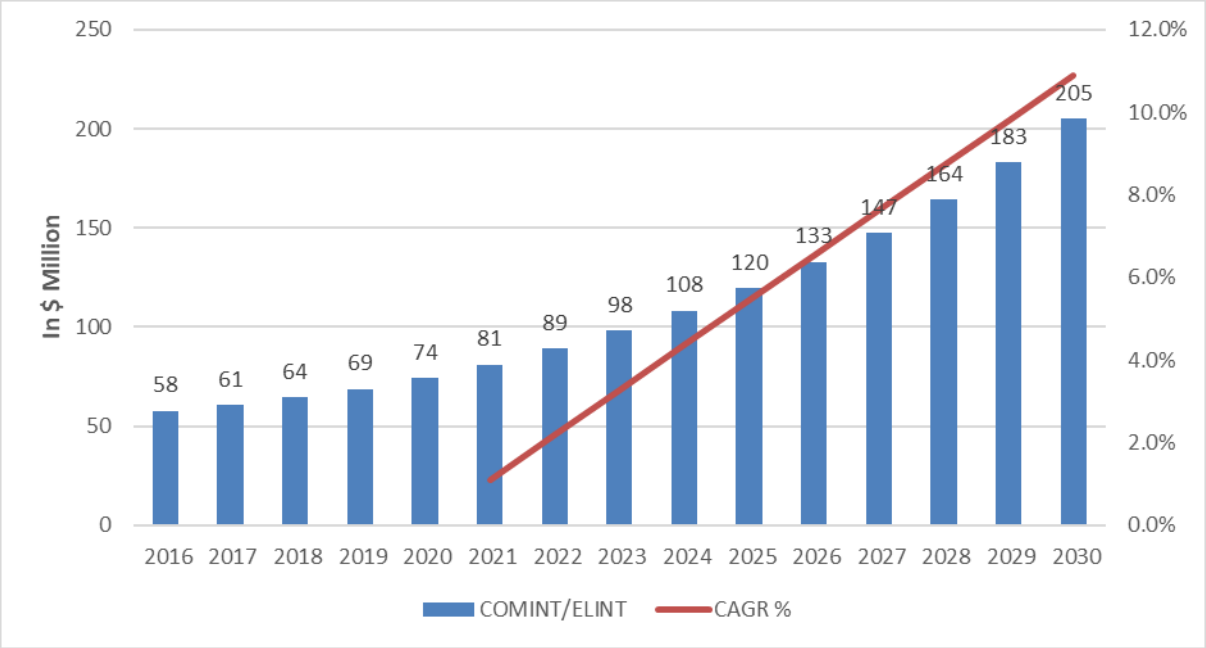


Figure 31- Ground COMINT/ELINT Market

Note: CY 2016-2020 is the actual market size. CY 2021 -2030 figures are estimated market size. CAGR line depicts the average growth rate during CY 2021-2030.

The ground COMINT/ELINT market was cumulatively worth ~ $ 326 million from 2016-2020 and grew at a CAGR of 6.5% during the period. The ground COMINT/ELINT market is expected to be worth approximately ~ 81 million in 2021 and is expected to reach ~ $ 205 million in 2030 at a CAGR of 10.89%. The total market for the forecast period will have a cumulative opportunity of ~ $ 1.3 billion driven by the above programs.

GLOBAL AND INDIAN SPACE INDUSTRY TRENDS

The Key Trends in the global space industry are as shown below.

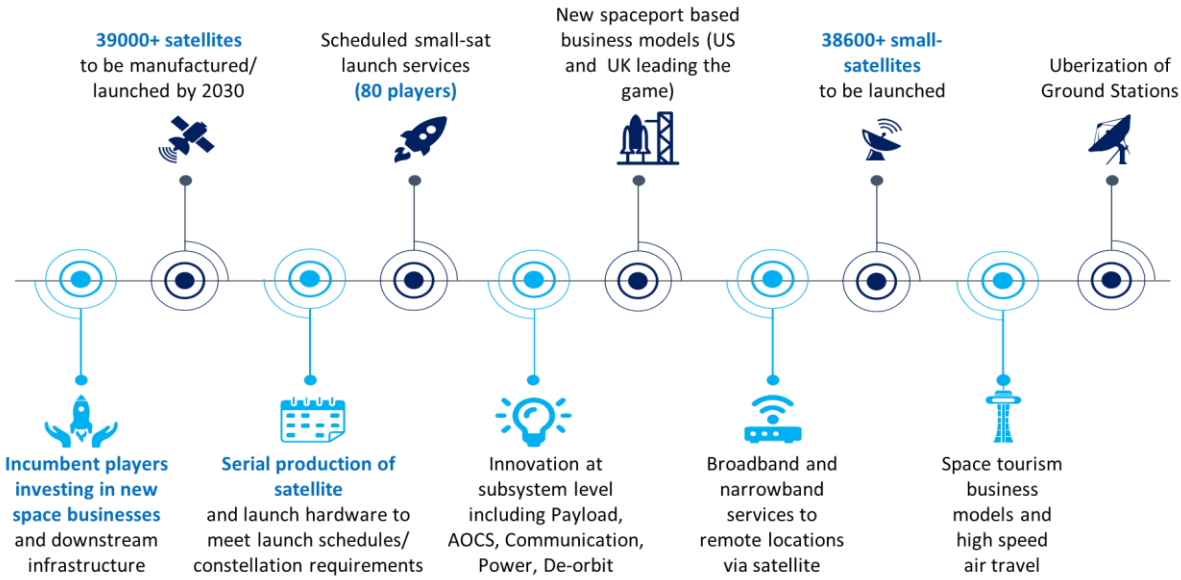


Figure 32- Global Space Industry Trends, 2021-2030

The global trends are also being replicated in the Indian ecosystem as the Indian Space Research Organisation (ISRO) is making a concerted effort to evolve the Indian ecosystem with transfer of manufacturing technology and shift in policy framework. The discussion of the space industry trends with respect to global and Indian ecosystem is placed in succeeding paragraphs.

Small Satellites and Mega Constellations

Small satellite mega constellations are driving the demand for satellite and subsystems manufacturing

Technology advances have enabled lower weight payloads to meet customer requirements in earth observation, communication, and technology demonstration. These roles were traditionally being fulfilled by heavier satellites in geosynchronous and medium earth orbits; however they are now being fulfilled by small satellite constellations in Low Earth Orbit (LEO). The technology advance has also been aided by gradual opening of the market to commercial players which has attracted multiple small satellite players in the industry to plan and launch small satellite constellations. The LEO constellations are generally planned up to a height of 1000

Kms, which offers advantages of higher resolution, lower latency and higher frequency of revisit. These characteristics of LEO satellites translates into gains for the end customer; for e.g. provision of global connectivity at a lower latency offers significant advantages in remote areas where the land infrastructure is either nonexistent or too costly to set up.

About 152 satellite operators have planned satellite constellations which accounts for about 23.75% of total documented satellite operators across all user segments. Notable example of mega constellation is the Space X plan of around 12000 LEO satellites for providing global connectivity. Amazon with project Kuiper has planned ~ 3200 satellites, while OneWeb has planned a constellation of ~ 700 satellites. The high number of planned satellites is driving the demand for serial production of satellites both for lower costs, and higher manufacturing output.

In accordance with the global trend of growing satellite constellations, domestic players such as Pixxel, Satsure, Vesta Space Technologies and Astrome are also aspiring for small satellite constellations. For e.g., Pixxel has planned a constellation of about 30 satellites. The efforts of the domestic players are yet to fructify, however it is expected that the demand from these players in the future will add to the ISRO driven demand.

Serial Production of Satellites

The rise in demand of small satellites is leading to serial production of satellites. Domestically, the small satellite demand will add to ISRO demand. Indian private industry will also benefit from the ISRO initiative of outsourcing manufacturing.

With multiple commercial satellite operators entering the space industry, the demand for large number of satellites to be manufactured has risen exponentially. Additionally, the launch time constraints demand that the operators get their satellites manufactured in a timely fashion to align with the launch schedule. This rise in demand for satellite manufacturing has been driving the installation of serial production facilities across the globe. While satellite operators like OneWeb and Starlink have vertically integrated their satellite production, many others are relying on satellite system integrators who either operate or are in the process of installing their respective serial production lines. These serial production facilities aspire to assemble hundreds of small satellites on an annual basis.

The Indian space industry is largely built around ISRO which is the primary customer and satellite operator. However, owing to new policy changes and associated ISRO efforts, commercial startup companies have also entered the Indian space market. Pixxel is such a NewSpace startup enabled by ISRO policies, and supported by Data Patterns.

Apart from this, multiple commercial space industry participants have been engaged by ISRO with an aim of ISRO evolving into the primary satellite developer and mission controller, while commercial agencies will handle the serial production responsibilities aided by relevant technology transfer. Consequently, moving forward the domestic space industry in India will involve multiple commercial participants besides ISRO.

ISRO is collaborating with private and public sector players for satellite manufacturing and enhances their know-how through technology transfer as depicted below:

- Collaboration with Bharat Electronics: ISRO has collaborated with BEL for manufacturing of small satellites, microsatellites, rockets, electronic systems, and multi-junction solar cells for space applications.
- Collaboration with Consortium led by Alpha Design Technologies: Alpha Design Technologies is working with BEL and TASL to assemble 27 satellites for ISRO. This is first engagement by ISRO for serial production of complete satellites rather than just components or satellite systems.

ISRO's effort of engaging external agencies indicates its strategy to outsource serial production and focus on technology development rather than production. ISRO's dependency on external agencies is further expected to increase as it also plans to involve private players during development stages for programs like Ganganyaan. This indicates ISRO's shift towards research programs rather than focus on capabilities such as in-house manufacturing and system integration.

Uberization of Ground Stations

The ground stations have not yet evolved to catch up with the exponential increase of data transfer demand which has led to new business models such as uberization of ground stations. The same is especially applicable to India as there are no existing private industry providers. Early entrants will benefit from first mover advantage.

Globally multiple small-satellite operators are aiming to deliver diverse satellite-based imaging and connectivity services. While persistent surveillance and seamless connectivity tend to remain domain themes in their value propositions, near-real-time insights depend on frequent updates from the space assets. An important component of the ecosystem would be the ground stations, and their capability to communicate with the satellite. The ground network is yet to catch up with the exponential increase in demand, and is still evolving to enable the LEO constellation operations. Consequently, there is a large untapped market for suitable enhancements to existing mission operations mechanisms.

Multiple aggregator business models are being built using digital platforms by participants such as RBC Signals and Infostellar which are aiming to resell excess available capacity with existing ground station terminals. These digital platforms not only allow the ground station terminal operators to generate additional revenue, but also provide cost-effective mission operations options to NewSpace participants. The business model may be likened to the Uber model, where satellite data exchange is facilitated through the relevant ground station, which then further relays it to the client via secure automated digital process.

In India, ISRO Telemetry Tracking and Command Network (ISTRAC) plays a pivotal role in providing ground segment for LEO and inter-planetary space missions, regional navigation systems, and launch vehicle missions. ISTRAC has ground stations across Hyderabad, Bengaluru, Lucknow, Port Blair, Sriharikota and Thirvananthapuram in India in addition to 09 global ground stations. ISRO is also

planning to conduct LEO missions, and hence will require the support of an expansive ground station network and the aggregator platforms for cost-effective solution. India has also agreed to set up 5 more ground stations in Bhutan, Nepal, Maldives, Bangladesh and Sri Lanka along with installation of 500 Very Small Aperture Terminal (VSAT). Currently, the key demand for ground station services and ground station equipment is mainly driven by ISRO. However, in the future the demand will also be driven by private satellite operators who would establish ground stations in the country to provide downstream services. For e.g. the ground stations planned to be set up in North, South and Western parts of the country by Bharti Enterprises to provide services in India through OneWeb constellation.

Domestically, there are no players addressing the ground station capacity demand through aggregator models, and early entrants are likely to benefit from first mover advantage.

Space System Testing

The mass production of satellites also necessitates the need for testing and validation. The industry has shifted to model of end of assembly line testing as seen in the automotive industry. Domestically, the testing demand will be driven by ISRO missions, and testing equipment suppliers to ISRO will benefit from the increased demand.

The serial production format of satellite manufacturing also has a positive downstream effect on testing and validation. Previously, dedicated assembly lines were developing one satellite and launch vehicle at a time, and testing and validation of satellite and launch vehicle subsystems/components was being outsourced to specialist testing agencies located physically away from the primary manufacturing facilities. However, with serial production getting installed, the satellite and launch vehicle manufacturing facilities are being forced to internalize significant portion of the testing processes. This has led to integration of end-of-line testing with the assembly line, similar to that of the automotive industry.

While multiple satellite and launch vehicle manufacturers, especially the Tier-1 participants have the resources to install the testing facilities in their assembly lines, it is not resource-efficient for them to evolve the testing capabilities from scratch. This will create opportunities for space system testing equipment participants within the satellite and launch vehicle manufacturing market. In addition, new space exploration programs and deep space missions will require additional testing equipment indicating increased demand for development of custom testing equipment in addition to existing demand.

Domestically, the demand for testing equipment will be mainly driven by ISRO. ISRO has also made its testing facility/ equipment available to private players as per new policy framework, to minimize their capital investment and grow the space ecosystem in the country. Thus, majority of the domestic players are expected to opt for testing facilities from ISRO due to lower capital investment and reduced need for additional testing set-up. Space exploratory missions and planned programs like Gaganyaan will also increase the demand in short-term for testing equipment. The domestic suppliers to ISRO will stand to benefit from the increased demand.

COTS for Space

The demand for COTS components in low weight satellites has increased due adoption of Pico, Nano and Micro satellites. Data Patterns is well positioned to capture this demand owing to it capability of building nano satellites from scratch including the required components

Need for faster and cheaper solutions for space has increased adoption of light satellite solutions such as Pico (<1 Kg), Nano (1-10 Kg) and Micro satellites (10-150Kg). These solutions are being adopted across innovative missions with unique payloads. The project timelines for satellite development have also reduced to as low as 09-24 months from inception to operations depending on the satellite weight and class. Prequalified space components and commercial off the shelf components (COTS) components are the key enablers to achieve such shorter timelines.

The miniaturization of electronics has increased adoption of COTS in the space industry. However, the level of adoption of COTS depends on the mission type and objective. In addition, key factors that are critical to adoption of COTS are reliability and performance when exposed to radiation and extreme temperatures. For example, use of COTS batteries is most common in CubeSats but as they are not designed for space environment, they need additional testing. The advantage of using COTS batteries is brought out by the fact that the impact of capacity loss is minimal up to 0.1% in case of Li-ion batteries in LEO[71].

Data Patterns experience of building key components such as on-board computer, Li-ion batteries, electric power system, power distribution module, power distribution expander, transmitters for nano satellite manufacturing positions it well to cater to this demand. This adds to previous experience to build full solution for ISRO and other commercial players in a customized requirement.

The demand for the light satellite solutions is increasing significantly due to multiple planned satellite constellations and easy plug and play approach possible to assemble CubeSats.

INDIAN SPACE INDUSTRY

Indian Space Evolution

The Indian space industry has evolved with ISRO outsourcing manufacturing to private industry. The evolution has helped private players like Data patterns to evolve their technical capability in addressing domestic and global demand.

Launch of the Aryabhatta satellite was the first key milestone for the Indian Space Program as shown in the Figure 33. .Subsequently, ISRO successfully executed

[71] A Review of Battery Technology in CubeSats and Small Satellite Solutions

Chandrayaan-1 & 2, and Mangalyaan missions which are indicative of ISRO's technical capabilities.

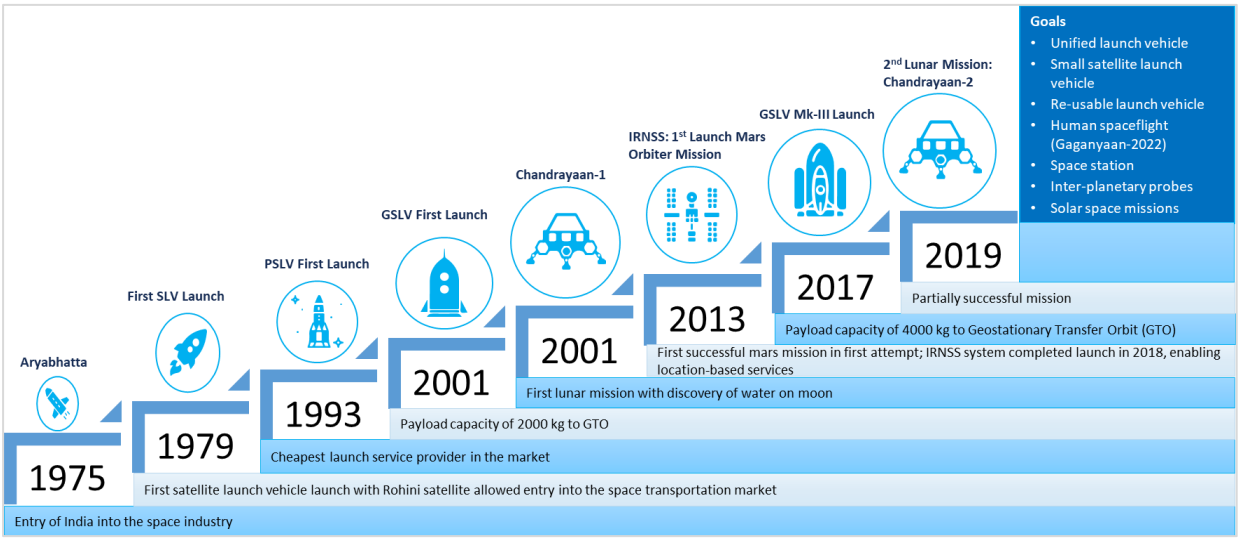


Figure 33- ISRO's Key Milestones.

ISRO has been a key enabler for domestic space ecosystem by procurement of satellite & launch vehicles systems and components through Tier I/II suppliers. It has opened up additional opportunities for private players through its approach of outsourcing of complete satellite manufacturing, and production of PSLVs and Geo Synchronous Satellite launch Vehicles (GSLVs) through the Government Owned Company Operated (GOCO) model. This shift in ISRO's approach has enabled multiple suppliers to expand their role from component manufacturers to system manufacturers, and system manufacturers to system integrators or full system developers. The technical capability gained through these missions has in turn positioned the domestic suppliers to cater for global demand.

Indigenous suppliers such as Data Patterns have strong anchorage in the domestic space industry through their capability to design and develop components/systems from scratch. Data Patterns also has capability to build to specifications in the space electronics equipment for satellite, ground station and testing. The company has also successfully expanded its role through development of full nano-satellite solution by building a satellite for private player like Pixxel, indicating their capability to cater to both sources of demand i.e., ISRO and New Space.

Indian Space Industry Expenditure and Forecast

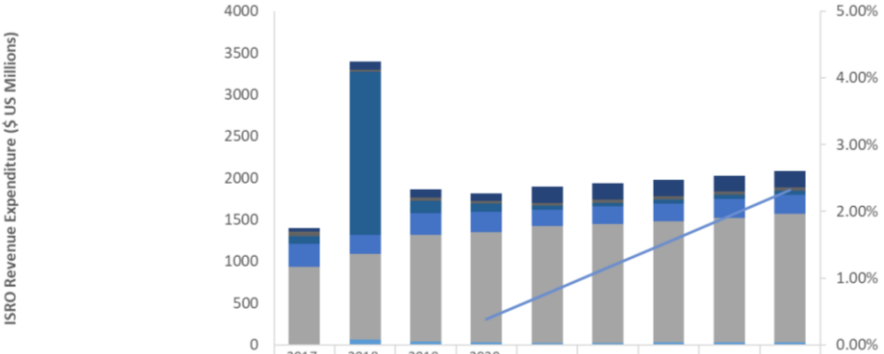
The ISRO revenue expenditure is forecasted to increase to $ 2085.68 million in FY 2025-2026 on back of increased missions.

ISRO's establishment expenditure has been increasing due to the incorporation of NSIL and IN-SPACe. About $132.09 million have been allocated as part of budget for establishment expenditure since FY 2019 up to FY 2021. This indicates government's agenda to drive further ISRO's efforts of engagement of private participants in Indian space industry. The creation of these entities has led to new opportunities for Indian private players through technology transfer and contract

manufacturing opportunities through NSIL and regulating body like IN-SPACe, which will enable private participants to establish their own services, establish own launch facilities and satellite operations.

In FY 2018 ISRO's revenue expenditure was about $1.39 Billion and about $1.86 Billion in FY 2020 i.e. growing at CAGR of 15.68%. However, a sudden spike in expenditure is seen in FY2019 due to expenditure on INSAT operational which amounted to 57.4% of the total expenditure. ISRO's Indian National Satellite (INSAT) system had about 200 transponders boosted. The system provides services for broadcasting, telecommunications, weather forecasting, search and rescue operations and disaster warning.

There is a shift of focus of ISRO of being a key driver for new technology development which is reflected from the increased space technology budget by 56.7% in FY 2022 when compared to FY 2020 revised budget and about 14% increase when compared to FY 220 budget. Another factor contributing to rise of budget for space technology is increased contract manufacturing and serial production requirements of ISRO for satellites and Launch Vehicles. Space applications expenditure will see constant growth until FY 2026, as will space sciences and space applications, with an increasing focus on these missions.



	2017-2018	2018-2019	2019-2020	2020-2021	2021-22	2022-23	2023-24	2024-25	2025-26
Total	1396.87	3395.67	1865.83	1817.96	1898.07	1936.66	1976.66	2030.14	2085.68
Direction & Administration and Other Programmes	37.44	97.25	102.45	89.32	194.76	194.76	194.76	194.76	194.76
Space Sciences	61.16	28.41	40.03	35.74	37.35	38.09	38.85	40.02	41.22
INSAT Operational	89.01	1949.32	143.22	101.22	44.84	45.74	47.11	48.53	50.47
Space Applications	274.75	233.76	264.52	244.11	200.93	208.96	217.32	223.84	230.56
Space Technology	934.51	1024.72	1276.77	1316.53	1394.55	1422.44	1450.89	1494.42	1539.25
Establishment Expenditure	0	62.21	38.84	31.04	25.64	26.67	27.73	28.57	29.42

Figure 34 - ISRO's Revenue Expenditure Forecast

Note: FY 2018-FY 2021 values are actual. FY 22 is projected budget. FY 23-FY 26 are estimates based on planned missions by ISRO.

Despite revised budget being lower for FY 2020-2021, FY 2020 has been progressive year for Indian space industry as COVID-19 has only spiked participation of private players within the local industry ecosystem, as recent policy changes allow a level playing field, allowing their participation in technology development for space exploration, Gaganyaan and deep space missions. This

indicates the shift in ISRO's role from being a monopolistic player in domestic industry to being an enabler for private space ecosystem.

On-going efforts of ISRO

ISRO has planned multiple deep space and experimental missions to strengthen India's position in global space industry through new technology development.

Recent Indian Missions

The graphic below shows the recent Indian missions from CY 2018-H1 2021. ISRO has successfully launched about 16 satellites and 1 exploratory mission during this timeline. About 35.29% of the total missions were Earth Observation, while 29.41% were communication satellites. Other salient aspects are:

- The data includes one successful launch by a private player in 2018
- 5 university satellites were launched in 2021
- 31 satellites are panned to be launched in 2021-2022. 54.38% of these are earth observation and 12.9% are communication satellites.
- The total number of ISRO satellites/ missions have steadily increased from 8 in 2018 to the current plan of 31 satellites in 2021-2022 indicating an almost 400% rise. The trend bodes well for the Indian space industry

ISRO	
2018	Microsat
2018	INS 1C
2018	Hysis
2018	Cartosat 2F
2018	GSAT-6A
2018	IRNSS-1I
2018	GSAT-29
2018	GSat 7A
2019	GSAT-31
2019	RISAT 2B
2019	Cartosat 3
2019	RISAT 2BR1
2019	Kalamsat v2
2019	Chandrayaan-2
2019	EMISAT
2020	CMS-1
2020	GSAT-30

Exceed Space	2018	Exceedsat 1
DRDO, PES University	2021	SindhuNetra (RSAT)
Space Kidz India	2021	SDSAT (Satish Dhawan Sat)
Jeppiaar Inst of Technology	2021	JITSat (UNITYsat 1)
G.H. Raisoni College of Engineering	2021	GHRCEsat (UNITYsat 2)
Sri Shakthi Institute of Engineering and Technology	2021	Sri Shakthi Sat (UNITYsat 3)

Satellite Missions	2018	2019	2020	2021-22
Earth Observation Satellites	2	4	1	17
Communication Satellites	4	1	2	4
Navigation Satellites	1	0	0	4
Space Exploration satellites	0	1	0	3
Technology Demonstrator	1	0	0	1
GAGANYAN	0	0	0	2
Total	8	6	3	31

Figure 35 - Historical and Planned Indian Missions, 2018-2022

ISRO Planned Programs

ISRO Programs	Description	Effect on Space Industry Participants
Space Telescope Observatory	Astrosat was the first dedicated astronomy mission in India utilizing X-ray, optical and UV band	This mission indicates the shift in focus of ISRO towards scientific applications and

ISRO Programs	Description	Effect on Space Industry Participants
Mission	simultaneously, and was launched in 2015 with mission life of 5 years. The second space science mission, the X-ray polarimetry satellite (XPoSat), is planned to be launched by end of 2021. The mission is aimed at study of polarization of cosmic X-rays.	technology development from basic services. Even though the nature of mission is not recurring, it increases the technology know how for the Indian space industry through technology transfer from ISRO. By working with ISRO on such missions the private space players can expand their technical capability portfolio, which can be leveraged for other product development and subsequent missions.
Deep Space Missions to Moon, Venus, Mars and Sun	India has planned multiple deep space missions focusing on Mars, Venus, and Moon. Shukryaan-1 is first mission by ISRO expected to be launched in 2025 to study the Venusian environment using Synthetic Aperture Radar (SAR) and Venus Infrared Atmospheric Gases Linker (VIRAL) (developed by CNES in collaboration with Roscosmos). Mangalyaan-2, second Mars Orbiter Mission is scheduled for launch in 2024. Chandrayaan-3, third lunar exploration mission, is scheduled to be launched in 2022.	The engagement of private players for key system designs for these missions will be great opportunity for these players along with technical capability building. Some of the Critical systems of these missions are communication and on-board computers for obtaining and processing data. Thus, these missions are opportunity for electronics manufacturers in space such as Data Patterns, BEL, and Alpha Design etc. As these missions require extensive testing due to exposure to extreme environments, the demand for testing equipment is increased during the development phase of these missions. Data Patterns can cater to such a demand based on their previous experience of working with ISRO and similar projects.
NISAR Satellite	ISRO has planned NASA-ISRO Synthetic Aperture Radar (NISAR)	The private players such as Data Patterns can work with ISRO on

ISRO Programs	Description	Effect on Space Industry Participants
Mission	mission in collaboration with NASA scheduled to be launched in 2023. The mission cost is expected to be $143.11 million. The mission objective is to analyse the impact of climate change and natural hazards.	similar missions with international collaborations, which will enable them to develop components/systems to international standards which they can later leverage to build their product portfolio. In, addition they can expand their international customer base by leveraging their experience on similar projects.
Other Experimental Missions	Aditya-L1 is small satellite, LEO mission with multiple payloads to study sun and surrounding atmosphere, which is scheduled for launch in Jan 2022.	The private players such as Data Patterns, Paras Defence and Space Technologies Ltd, Alpha Design etc. can participate in experimental missions, which will enable them to enhance their existing R&D capability based on the set requirements for mission. Thus, improving their technical capabilities. Success of similar missions will increase customer confidence and prove product reliability which is a key factor for opting for a particular component/sub-system or system.
Development of New Launch Facility and Launch Vehicle	Establishment of second spaceport by ISRO Kulasekharapatnam (Thoothukudi district), Tamil Nadu will enable multiple Small Satellite Launch Vehicle (SSLV) launches, and increasing launch slot availability for satellite operators,	The Indian industry will benefit from increased launch capacity which will in turn attract commercial satellite operators and drive revenue opportunities. Data Patterns, given their history of building second launch pad count down system for SHAR, will also benefit. In addition, the development of SSLV by ISRO will need additional testing equipment which can be good opportunity for testing equipment suppliers such as Data Patterns.

ISRO Programs	Description	Effect on Space Industry Participants
Gaganyaan	Gaganyaan is a part of Indian human spaceflight programme. First and second test flights are planned respectively in 2022, 2023, while the and first crewed flight to LEO is slated for 2023.	The development phase of the spacecraft involves development of life support, communication, guidance, navigation, and control systems. These systems will need involvement of space electronics manufacturers such as Data Patterns. In addition, due to the nature of program extensive amount of testing is required during the development phases. This is an opportunity for testing equipment manufacturers such as Data Patterns. Data Patterns has already delivered cable tester for this programme, positioning them well for supplying similar testing equipment during the course of the program.

Table 13 - ISRO Planned Programs

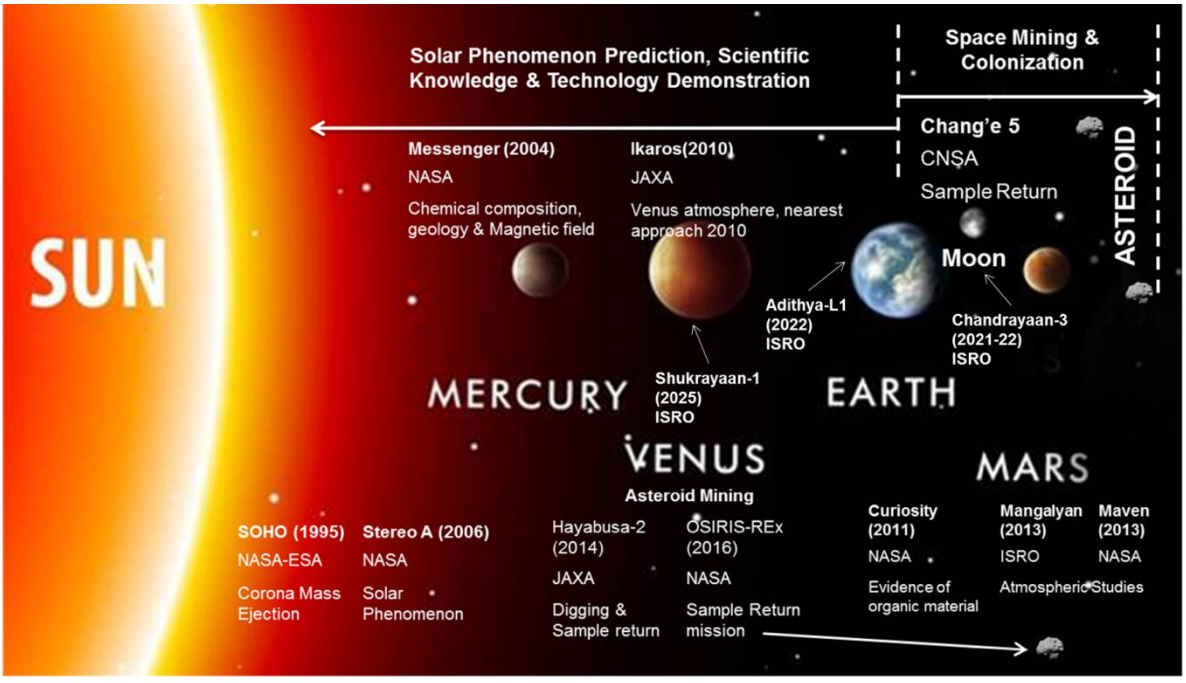


Image Source:https://cdn.thinglink.me/api/image/766728430564671490/1240/10/scaletowidth

Source: Frost & Sullivan

Figure 36 - Deep Space Missions, Historical and Planned

Indian Space Industry Ecosystem

Space Industry landscape has been expanding with entry of multiple private players and announcements of changes in regulatory framework.

ISRO has traditionally been the key enabler for domestic space ecosystem by contracting subsystem and component manufacturing to private players. However, additional opportunities are now feasible with entry of new space participants such as Skyroot Aerospace, Agnikul Cosmos, Pixxel, SatSure etc. who are planning to provide both launch services, and services for remote sensing applications similar to what ISRO provides. This shift in the industry landscape is driven by the Atmanribhar initiative, and ISRO establishing level playing ground for the private players. As brought out earlier, the establishment of IN-Space, and NSIL has also helped the private industry. IN-SPACe is the nodal agency to access current ISRO facilities and obtain permits/licenses for operations, while NSIL is the enabler for technology transfer and contract manufacturing of PSLV and SSLV. Figure 37 show the key participants in the space industry.

Figure 37 - Indian Space Industry Ecosystem

Regulatory Framework and Policies

ISRO is enabling commercial domestic players with liberalization of the regulatory framework and policies

Policy	Change Description	Effect on Indian Space Industry
SATCOM Current and Draft Policy	As per current SATCOM policy, Indian satellite capacity utilization is prioritized over international satellites through INSAT Coordination Committee (ICC). However,	This shift in policy removes the barrier of access to international satellites for domestic players, enabling

Policy	Change Description	Effect on Indian Space Industry
	the new draft policy permits the satellite operators to offer satellite capacity allocation directly to customer domestically and internationally for commercial and societal applications.	them to have multiple alternatives for pricing rather than pricing through single entity. This will allow satellite operators to establish downstream connectivity services at lower cost.
SATCOM and Remote Sensing Draft Policy	Indian entities can launch and operate their own satellites and establish ground stations, and satellite control centres in India or globally with appropriate authorisation.	Permitting satellite operators to launch and operate their own satellites will enable the domestic players to compete in global market to provide downstream satellite services through their own satellite constellations. This would in turn increase demand for domestic satellite manufacturing players.
SATCOM Draft Policy	Fresh authorization is required in case of change of ownership for establishing space-based communication system in India global. This is also applicable to NGSO communication systems and establishing ground segment for space asset operations.	Requirement for fresh authorization as per draft policy indicates that a company having previous authorization for establishing space-based communication system or ground segment will need fresh authorization in case of merger and acquisition. This makes it challenging for commercial operators in case of change of ownership is involved
SATCOM Draft Policy	The communication requirement related to national security, strategic communications, surveillance and critical economic transactions will be developed indigenously under direct control of the government through Department of Space (DoS).	Opportunity for the satellite manufacturers for defence applications in the domestic market will be through Department of Space (DoS). Indian private industry

Policy	Change Description	Effect on Indian Space Industry
		participants are more likely to be part of defence applications.
Remote Sensing Draft Policy	Indian industry participants can access satellite manufacturing and ground segment facilities from the government on commercial terms, based on availability. However, any change in ownership or replacement of the space asset will need fresh authorisation.	Commercial players will have access to government facilities on demand based on availability. This would reduce the need for setting up of ground stations in the country for small satellite constellations. In addition, easier access to manufacturing facility indicates the possibility of satellite operators extending their role to include satellite manufacturing to reduce cost thus minimizing procurement from third parties.
Indian FDI Policy	"Satellites- establishment and operation, subject to the sectoral guidelines of Department of Space/ISRO[72]" The percentage of FDI Equity Cap is 100% and the route for FDI investment is government.	This indicates that international players have opportunity to invest in Indian Space companies post clearance from Department of Space (DoS).

Table 14 - Regulatory Framework and Policies

GLOBAL & INDIAN SPACE ELECTRONICS MARKET

Global Satellite Manufacturing Market Opportunity

Frost & Sullivan estimates 39,033 satellites to be launched from 2021-2030. About 98.99% of the demand is from small satellites of which 49.01% of the demand is from satellites weighing less than 75 Kg.

The growth in number of satellites has been phenomenal in 2020[73] i.e. about 1221 satellites were launched in 2020 as compared to 406 in 2019, which is a 300% rise in total number of satellites launched. Similar spike has been observed in H1 of 2021, and about 1281 satellites have already been launched till now. This is more

[72] https://dipp.gov.in/sites/default/files/FDI-PolicyCircular-2020-29October2020_1.pdf

[73] **Note : All data, forecasts and discussion pertains to CY for both global and Indian market opportunity**

than the total number of satellites launched in 2020. The exponential rise is due to the growth of mega constellations as discussed earlier.

Frost & Sullivan estimates that 39,033 satellites will be launched from 2021-2030 as shown below. Small satellites (satellites weighing <500Kg) are driving this demand as 98.99% of the demand is from small satellites, of which 49.01% of the demand is from satellites weighing less than 75 Kg. This mass class (0-75Kg) covers all key user segments such as university, commercial, military and civil government. The market share by user segment for 2021-2030 is as shown in below:

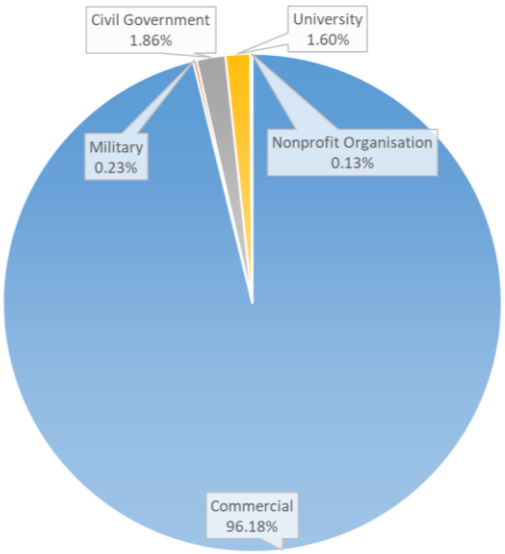
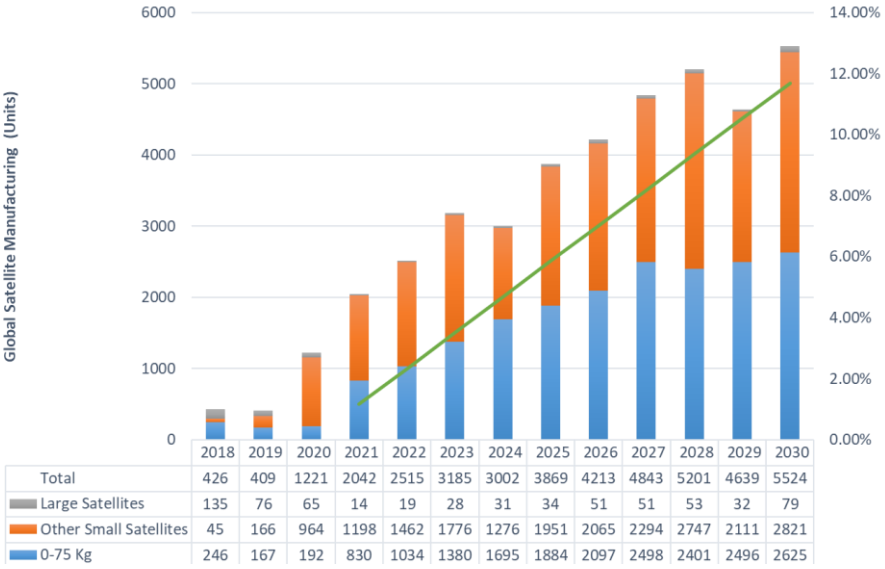


Figure 38- Global Satellite Manufacturing Market share by User Segment for Mass Class (0-75Kg), 2021-2030

The total demand consists of the new satellites as well as the replacement satellites for continued offering of services. The peak in 2023 and 2028 in the forecast is a consequence of overlap of new and replacement satellites. The demand in 2030 is mainly driven by subsequent phases of satellite constellations being launched.



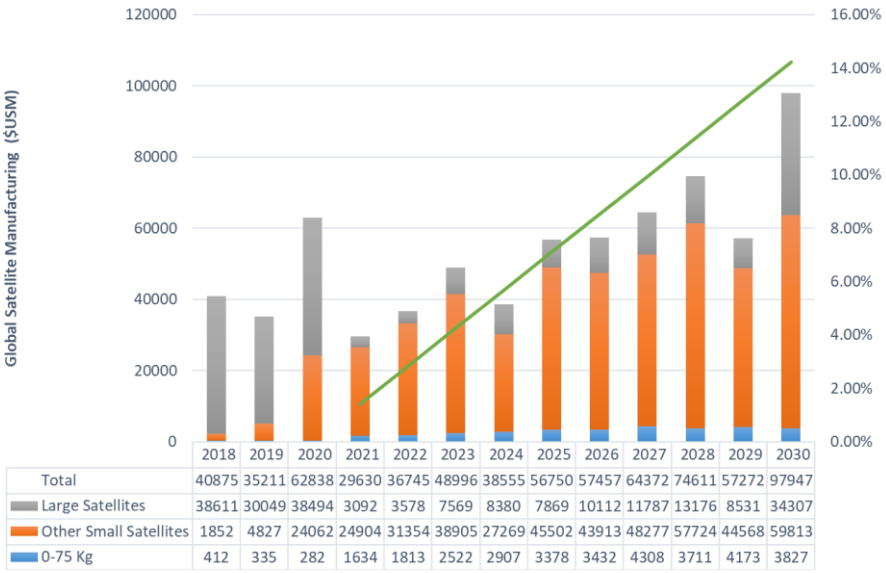
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total	426	409	1221	2042	2515	3185	3002	3869	4213	4843	5201	4639	5524
Large Satellites	135	76	65	14	19	28	31	34	51	51	53	32	79
Other Small Satellites	45	166	964	1198	1462	1776	1276	1951	2065	2294	2747	2111	2821
0-75 Kg	246	167	192	830	1034	1380	1695	1884	2097	2498	2401	2496	2625

Figure 39 - Global Satellite Manufacturing Forecast (Units; No. of satellites), CY 2021-2030

Note: CY 2018-2020 values are historical and CY 2021-2030 are forecast based on new installations and replacement of satellites. CAGR line depicts the average growth rate for CY 2021-2030

Historically the revenue for satellite manufacturing was predominantly by large satellites i.e. about 94.4% of the total revenue in 2018 and there has been a decrease in percentage revenue to about 61.25% in 2020 and further decrease of revenue is anticipated for larger satellites during the timeline. This is mainly due to shift towards utilization of small satellites and associated lower manufacturing costs per satellites.

Frost & Sullivan's satellite manufacturing database estimates that the global satellite manufacturing revenues for 2021 is $29.62 Billion, and is expected to grow to $97.94 Billion by 2030, at a CAGR of 14.21% as shown below. Within this forecast, 80.72% are small satellites. The demand from 0-75 Kg mass class is $1.63 Billion in 2021 and is expected to grow up to $3.82 Billion by 2030, growing at a CAGR of 9.93%.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total	40875	35211	62838	29630	36745	48996	38555	56750	57457	64372	74611	57272	97947
Large Satellites	38611	30049	38494	3092	3578	7569	8380	7869	10112	11787	13176	8531	34307
Other Small Satellites	1852	4827	24062	24904	31354	38905	27269	45502	43913	48277	57724	44568	59813
0-75 Kg	412	335	282	1634	1813	2522	2907	3378	3432	4308	3711	4173	3827

Figure 40 - Global Satellite Manufacturing Revenue Forecast (CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 values are projections based on the number of satellites to be launched and variation of pricing by mass class for manufacturing of satellite.

About 54.55% of the total market revenue from 2021-2030 is estimated to be from North American Region which accounts for about 50.53% of total global demand in terms of number of satellites. The major mass segment in the region is 150-250Kg which has market share of 79.74% of the total market revenue. Key satellite operators in the region are SpaceX, Telesat Canada and Lynk. Satellite manufacturers from this region are Blue Canyon Technologies, Boeing, Harris, and Magellan Aerospace.

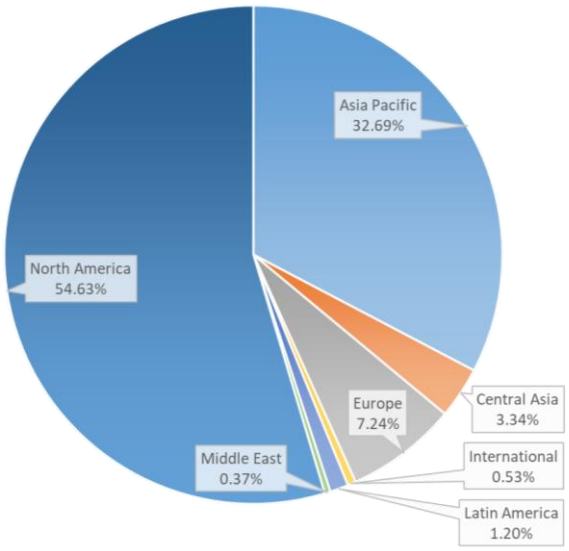


Figure 41: Global Satellite Manufacturing Regional Market Share, CY 2021-2030

Asia Pacific region is estimated to have market share of 32.64% (2021-2030) in terms of revenue driven by demand of 9555 satellites. Key Mass Class is 150-250

Kg segment followed by 75-150 Kg segment which contribute to 20.60% and 13.96% of revenue respectively. Key satellite operators driving the demand are Galaxy Space, Axel Space, Chang Guang Satellite Technology, Synspective and Xingyun Satellite Co. Satellite Manufacturers in the region are Alpha Design Technologies, Inovor and Data Patterns.

The demand from commercial segment is the highest and accounts for a market share of about 82.02%. This segment is growing at a CAGR of 12.21%. Next key segment is military which is growing at CAGR of 48.70%. Other user segment such as university (0.20%) and non-profit organizations (0.01%) have a lower demand. The highest demand from 0-75Kg mass class is commercial followed by Civil Government. The demand for 0-75 Kg mass class is expected to grow at CAGR of 10.46% for commercial user segment and 0.44% for Military.

The global demand by application is highest for communication applications followed by EO and IoT/M2M applications. The total demand for communication is about $21.75 Billion in 2021 and $70.69 Billion in 2030. Key user-segment for this application is commercial and accounts to about 96.98% of communication satellite manufacturing market share and civil government of up to 1.92%.The demand for EO is about $4.59 Billion in 2021 and $17.76 Billion in 2030 growing at CAGR of 16.22%. This demand is mainly driven by the commercial players such as SpaceX and OneWeb. The demand for EO missions is from combination of planned satellite constellations and replacement mission from operational constellations.

Indian Satellite Manufacturing Market Opportunity

Historically, the number of satellites launched by ISRO has been declining from 2018 to 2020 from 9 satellites to about 2. The decline in 2020 is a consequence of revision of ISRO's budgets leading to delay in missions. However, ISRO has contracted about 27 satellites to be assembled to consortium of 3 companies: Alpha design technologies, BEL and Tata advanced systems, indicating increase in number of satellites to be launched by ISRO in the future. Figure *42* shows the market opportunity for satellite manufacturing in India. In short-term the market opportunity is mainly driven by ISRO followed by shift in 2025 where the opportunity is driven by private players in terms of number of satellites by Indian startups such as Pixxel, Satsure, Vesta Space Technologies and Astrome who are aspiring for small satellite constellations, and this indicates the possibility of a growing Indian small satellite market involving commercial players besides ISRO. Pixxel is aiming to achieve an earth observation constellation of 30 small satellites. The total opportunity for India is about 161 satellites from 2021-2030.

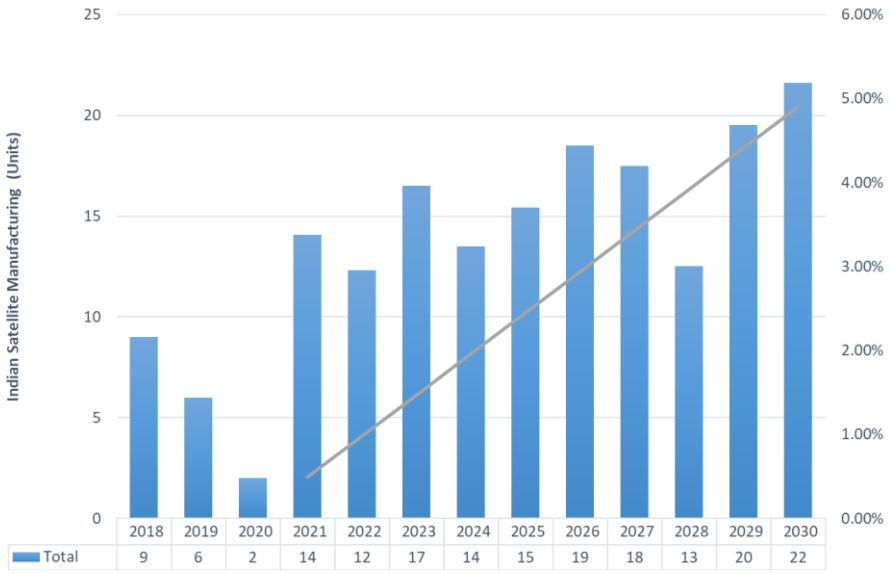


Figure 42 - Indian Satellite Manufacturing Forecast (Units; No. of Satellites CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 values are projection based on planned missions, satellite constellations and replacement satellites.

Historically the revenue for satellite manufacturing has reduced in the last two years owing to the reduction in number of satellites launched i.e.77.3% decrease. Frost & Sullivan's estimates the Indian satellite manufacturing revenues to be $803.26 Million as of 2021, which is expected to grow up to $1061.5 Million by 2030, growing at a CAGR of 3.15%. The 0-75Kg segment is estimated to be $0.95 Million as of 2021 and is expected to grow up to $3.39 Million by 2030, growing by a CAGR of 15.18% for the Indian Market.

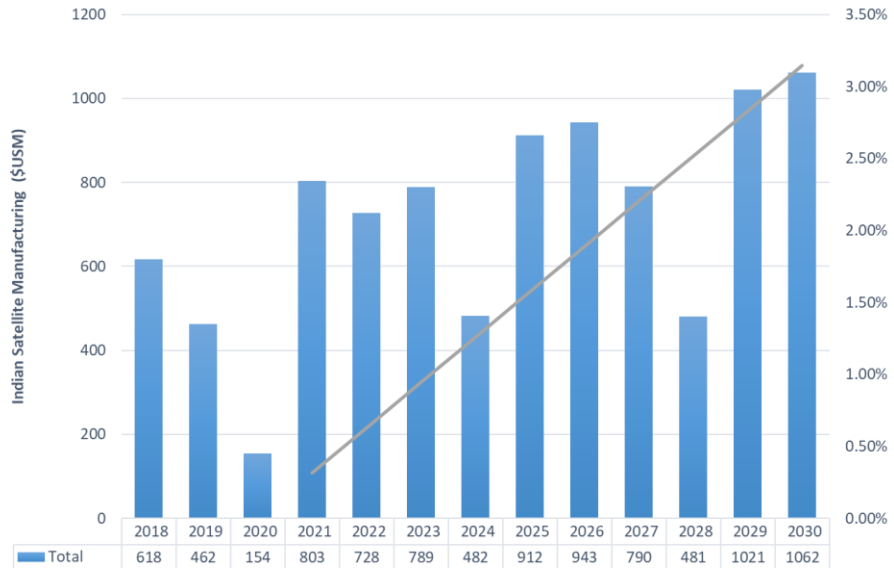
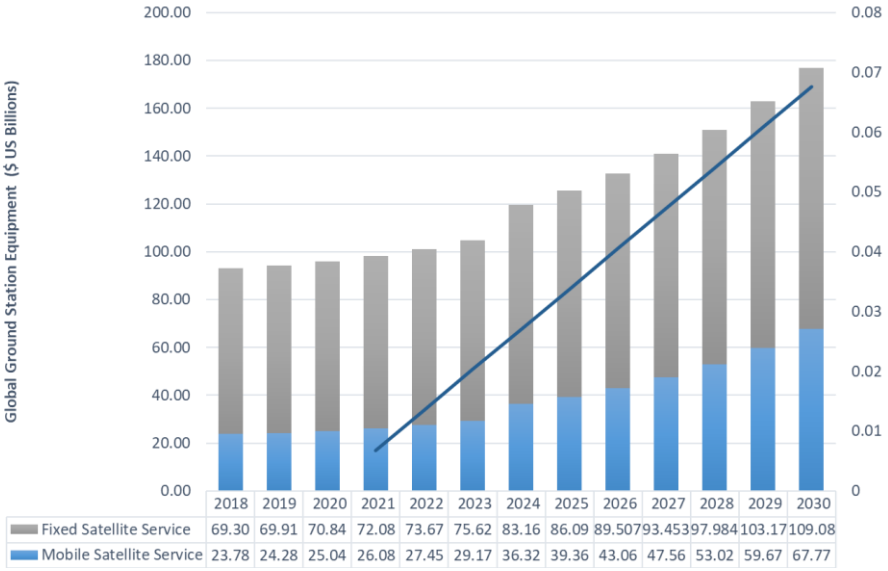


Figure 43 - Indian Satellite Manufacturing Revenue Forecast CY 2021-2030

Note: CY 2018-2020 values are historical and CY 2021-2030 are projections based on number of satellites and manufacturing price per satellite based on mass class.

The demand for Indian market is mainly driven by civil government and commercial sectors having a market share of 88.70% and 11.29% respectively. The Key applications for the sector include IoT/M2M, Technology and Communication. In case of IoT/M2M the demand is 100% from commercial players. For Technology, the demand is mainly driven by Civil Government having a market share of 99.92%.

Global Market Opportunity for Ground Stations



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fixed Satellite Service	69.30	69.91	70.84	72.08	73.67	75.62	83.16	86.09	89.507	93.453	97.984	103.17	109.08
Mobile Satellite Service	23.78	24.28	25.04	26.08	27.45	29.17	36.32	39.36	43.06	47.56	53.02	59.67	67.77

Figure 44 - Global Ground Station Equipment Forecast (CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 values are projections.

In 2018 the revenue for ground station equipment was $93.08 Billions and grew to $95.88 Billions in 2020 growing at CAGR of 1.49%. This increase is consequence of increase in demand for ground station equipment with planned ground stations being built to support additional capacity demand from small satellite constellations.

The total market opportunity for ground stations in the period 2021-2030 is about $1313.26 billion, growing from $98.17 Billion in 2021 to $176.85 in 2030 at a CAGR of 6.76%. The global demand is driven mainly from the additional ground segment capacity required for new satellite constellations. New small satellite operators such as RBC signals, SpaceIt are deploying aggregator models which tap excess ground segment capacity through a single platform. The model allows the satellite operators to utilize multiple ground stations customized to their requirements, enabling them to have multiple communication points with the satellite without higher investment in ground infrastructure. However, companies which have vertically integrated model such as SpaceX are setting up their own ground stations. With projected demand for about 39033 satellites to be launched from 2021-2030, the number for ground stations will also increase.

The Fixed satellite service (FSS) equipment is expected to grow at a CAGR of 4.71%, while the Mobile Satellite Service (MSS) is forecasted at a CAGR of 12.34%, indicating that the increasing trend of adoption of MSS equipment due to LEO constellations.

Indian Market Opportunity for Ground Stations

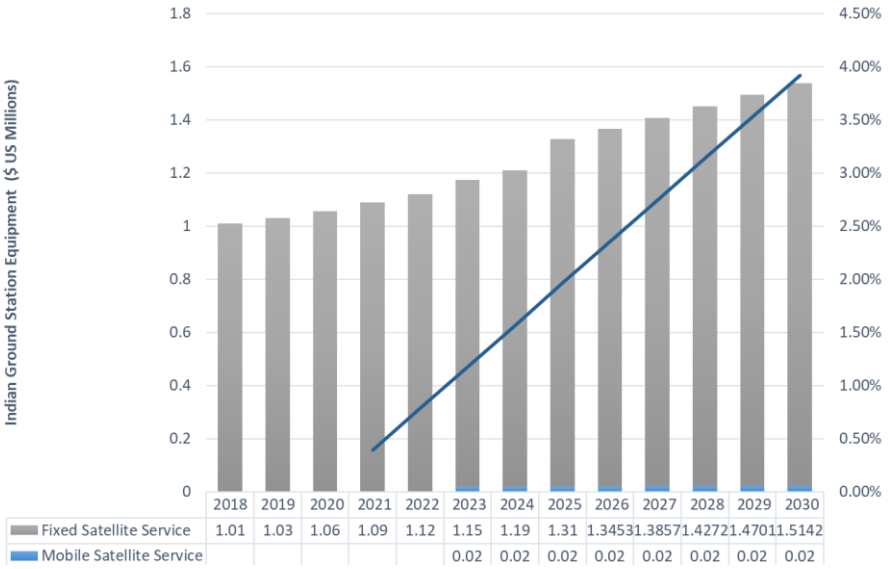


Figure 45 - Indian Ground Station Equipment Forecast (CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 vales are projections.

The demand for ground stations in India is mainly driven by ISRO. ISRO has well established ground stations and will require establishing further ground stations for the growing number of launches. Another factor driving the demand for ground station equipment in India will be operators planning to provide services in India from their satellite constellations. For e.g., Bharti Enterprises is planning to build ground stations across north, south, and western region of India for providing connectivity services domestically using OneWeb constellation. Figure 47 shows the opportunity for Indian Ground Station equipment. The Market has been growing steadily from $1.01 Million in 2018 to $1.06 Million in 2020 i.e., growing at a CAGR of 2.45%.The market size is estimated to be about $01.09 Million in 2021 growing to $1.54 Million in 2030 at a CAGR of 3.91%. The opportunity in short term is mainly from FSS equipment.

Global Market Opportunity for Testing Equipment

The demand for testing equipment is mainly at two stages. One is functional and other is end of the line testing. The demand for end of the line testing is expected to grow due to serial production of satellites which will require continuous testing after satellite integration. In addition, the demand for testing players will be driven by launch service providers as 62.77% of launch vehicles are under development stage and will need testing equipment. The market for testing equipment for space was about $3.06 Billion in 2018 and $4.71 Billion in 2020 growing at CAGR of 24.07%. The spike in 2020 is consequence of multiple deep space missions planned and serial production of satellites. The demand for testing Equipment is shown below and is projected to be $2.22 in 2021, and expected to grow to $7.34 in 2030 at a CAGR of 14.21%.

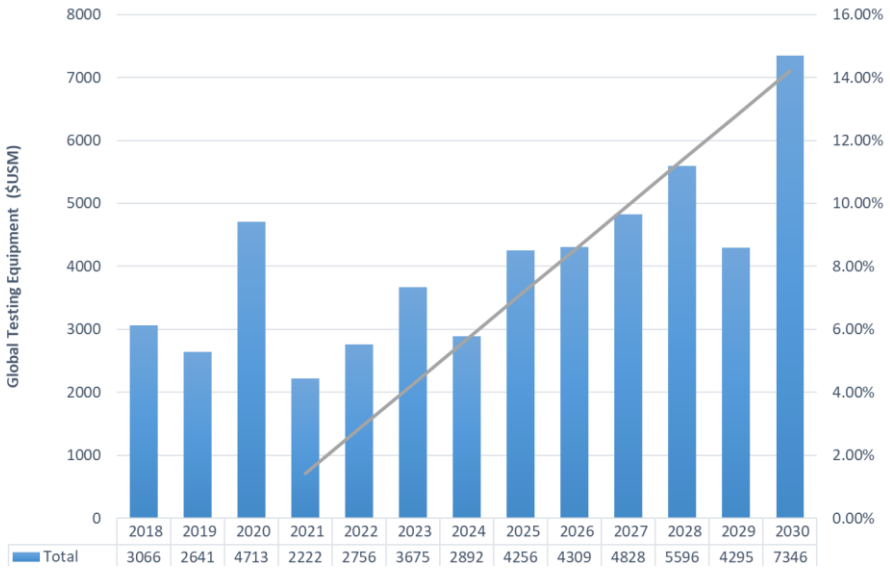


Figure 46 - Global Testing Equipment Revenue Forecast (CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 vales are projections.

India Market Opportunity for Testing Equipment

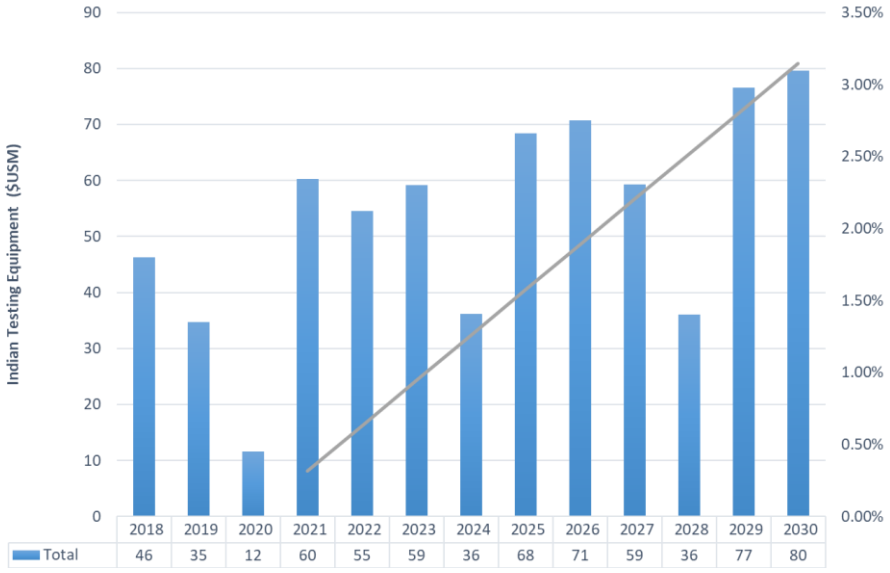


Figure 47 - Indian Testing Equipment Revenue Forecast (CY 2021-2030)

Note: 2018-2020 values are historical, and CY 2021-2030 values are projections.

The market Size for testing equipment in India in 2018 was $46 Million and $11.56 Million in 2020. The demand for 2020 was minimal due to COVID-19 impact on the domestic industry owing to the budget cuts of ISRO, and only 02 satellites being launched. The demand for 2021 is estimated to grow to $60.24 Million which is due to the pent-up demand from 2020 and the planned launches in 2021. This demand is expected to grow to $79.61 Million in 2030 at a CAGR of 3.14% indicating an overall positive trend. The sudden increases observed in years 2023, 2025, 2026, and 2029-2030 coincide with the testing requirements for end of line testing for serial production of satellites.

KEY INDUSTRY GROWTH DRIVERS

Atmanirbhar Bharat

ISRO's efforts to enable domestic private players coupled with 'Atmanirbhar Bharat" initiative will foster strong growth environment for domestic players.

ISRO's model has evolved and now also involves external agencies to conduct multiple programs and missions simultaneously. The 'Atmanirbhar Bharat' initiative has distinct focus on domestic players which will drive prioritization of Indian participants over international supply chain for procurement. International players will remain eligible for the opportunities in case they have partnership with domestic players. This indicates the opportunity for increase in international partnerships and inflow of investment. ISRO 's focus on enabling domestic private players through outsourcing of space systems manufacturing and Atmanirbhar Bharat provisions will create strong environment for growth opportunities for Indian participants.

Expansion of domestic private space industry landscape

Entry of private players in the market, the demand for manufacturing, testing and ground equipment will grow across system, subsystem, and component levels due to expansion of the customer base investing in space capabilities other than ISRO. This will further increase the opportunities for international space market participants and investment groups as technological and financial support from the global space value chain participants will be in demand.

Setting up of NSIL and In-SPACe

Expansion of commercialization effort by government by setting up of New Space India Limited (NSIL) is enabling the growth of space industry ecosystem.

Department of Space is creating opportunities to engage with existing and new private participants for Indian space program by evolving from supply-based model to demand-based model. New Space India Ltd (NSIL) was created for expansion of commercialization effort and integration of new space participants with Indian space programs and exploratory missions. This has created multiple opportunities for private space participants. Data Patterns is likely to benefit from these new opportunities from new model.

	Market Drivers	1–2 Years	2–3 Years	3–5 Years
Satellite Manufacturing	Increased demand from satellite operators for planned satellite constellations and planned exploratory missions by ISRO.	High	High	High
	Increased investment by government and private players on satellite development to provide adequate downstream services and Atmanirbhar Agenda.	High	High	Medium
	Increasing technology demonstration missions for testing new products, experimental payloads, and new technology development.	High	High	Medium
	ISRO's GOCO model for satellite manufacturing through NSIL will increase the opportunity for domestic component and system manufacturers and system integrators.	High	Medium	Medium
Ground Stations	Demand for setting up ground stations within the country by service providers like Bharti Airtel for providing connectivity service domestically utilizing the OnWeb constellation. Similar, trend is expected for planned LEO constellations.	High	High	Medium
	Increasing need for utilization of ground segment capacity at low cost through ground station as a service model.	Medium	High	High
	Established regulatory framework allowing private players to set up and operate own ground stations.	High	High	Medium
Testing Equipment	Increased exploratory and deep space missions, increasing the demand for new test equipment.	High	High	Medium
	Increasing end of line testing equipment for establishing satellite serial production capabilities	Medium	High	High
	Increasing demand for testing equipment for launch vehicle electronics and structures as multiple launch service providers are still in their development phases.	High	High	High

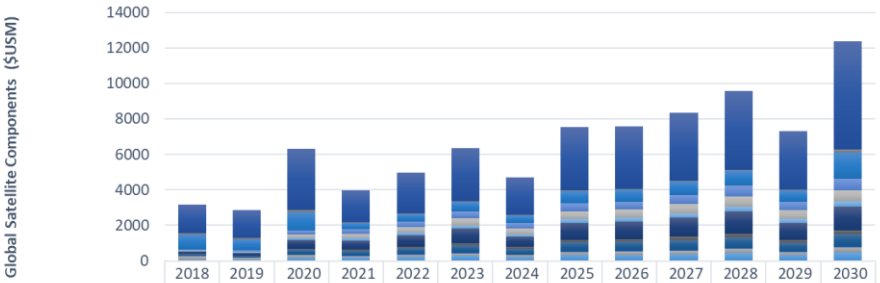
Figure 48 - Key Industry Drivers for Satellite Manufacturing, Ground Stations and Testing Equipment Markets.

OPPORTUNITIES FOR DATA PATTERNS SPACE PORTFOLIO

Satellite Manufacturing

Data Patterns has proven reliability of being a supplier to ISRO and has gradually expanded its role from sub-system manufacturer to complete satellite manufacturer. The technical competence and reliability positions Data Patterns well to compete in domestic and global space markets. New participants need to prove their product reliability through successful satellite launch and operations, but, as Data Patterns has worked with ISRO on multiple missions they have competitive edge over their competitors in the new space industry.

Data Patterns has an experience of design and development of hyperspectral satellite for Pixxel. During the process of development, Data Patterns has successfully developed subsystems and components such as on-board computer, electric power systems, Li-ion batteries, power distribution module, transmitter and transceiver, Gyroscope, magnetometer, sun sensor, magnetic wheels, magnetorquers, antenna and GPS receiver. The demand for each of the segments is as shown below.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
on-board computer	1593	1563	3442	1820	2311	2964	2080	3578	3515	3826	4448	3272	6088
power electronics	89	85	133	22	26	39	37	46	52	58	61	48	163
Batteries	844	630	1039	361	439	562	449	694	675	762	849	639	1508
Transmitter	43	56	207	250	304	390	311	445	449	515	580	483	620
Receiver	43	56	207	250	304	390	311	445	449	515	580	483	620
Transceiver	29	32	109	124	152	189	148	219	222	254	282	228	304
Gyroscope	129	144	507	525	661	831	573	960	998	1074	1276	957	1370
Magnetometer	18	15	38	64	80	101	100	126	138	158	168	152	180
Magnetic Wheels	95	97	294	285	353	433	335	524	515	581	646	506	726
Magnetotorquer	8	9	16	14	18	23	19	27	30	32	37	30	42
Antenna	207	124	145	84	107	138	128	170	192	210	226	175	278
GPS Receiver	61	58	177	177	223	281	195	324	339	365	432	323	467

Figure 49 - Global Satellite Manufacturing Components Forecast CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 vales are projections.

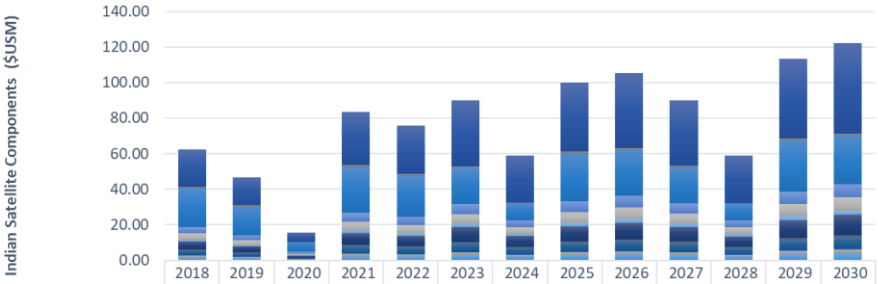
The global demand for on-board computers is about $1.82 Billion in 2021 growing up to $6.08 Billion in 2030 growing at CAGR of 14.34%. The demand for on-board computers is mainly driven by the 150-250 Kg mass class followed by >2500 Kg mass class. The demand from 0-75 Kg is growing from $31.28 Million in 2021 to $73.98 Million in 2030 growing at a CAGR of 10.04%. The exponential growth is a consequence of increased of number of satellites planned within this mass class. The respective Indian opportunity is about $29.79 Million in 2021 and about $51.18 Million in 2030 growing at a CAGR of 6.2%. One of the key features that is becoming crucial for on-board computers to support on satellites is software reconfigurability in order to meet changing demand of the end users. The software defined satellites allow alteration of satellite parameters such as power, coverage, frequency, bandwidth with satellite being in-orbit. This element of flexibility to meet demand of end users is quintessential for satellite operators to cater to end user requirements. Thus, Data Patterns on-board computer system supporting on-board software upgradation and full redundant configuration with two OBCs and redundant bus switch module, permits satellite software reconfigurability and increased system redundancy. This is in-line with the emerging global trend which positions Data Patterns well to compete in global market in addition to domestic market.

The demand for power electronics is about $22.45 Million in 2021 and grows up to $163.34 Million growing at a CAGR of 24.67%. The demand for this component is mainly driven by large satellites >2500 Kg about 40.79% followed by 150-250 Kg satellites at 19.82% and 0-15Kg at 10.30%. The key application driving the demand for 0-15 Kg segment is Earth observation. Data Patterns previous experience with hyperspectral satellite positions it well to cater to demand for power electronics for the key application. Data Patterns component portfolio offering includes electrical power systems, power distribution modules and power distribution expander.

The demand for batteries is growing at CAGR of 17.22% globally from $360.73 million in 2021 to $1.50 Billion in 2030. The demand for batteries is mainly driven by 150-250 Kg mass class with market share of 45.84%. The opportunity for 0-75 Kg segment is about 2.6% of the total market revenue. Batteries are critical component to operation of satellite and hence margin of error should be low. This demands tedious qualification and certification process to prove their ability to sustain in extreme environmental conditions, extreme temperatures, vacuum, vibration shocks and radiation. As light weight batteries are necessary with balance between higher specific energy and specific power, lithium-based batteries are preferred, as lithium is most electropositive metal with light weight. Also, they offer lower self-discharge rate and longer life cycle. Data Patterns product offering is Li-ion batteries for small satellites which are preferred solution. Thus, Data patterns is well positioned to offer batteries both domestically and globally.

The demand for transmitter, receiver and transceiver is growing at CAGR of 10.63%, 10.63% and 10.48% respectively. Key mass classes for transmitter are 0-250 Kg with key application being communication and user segment is commercial. Data Patterns offers S-Band and UHF-Band payload transmitter modules which are commonly used on nano satellites due to their ability to transmit easily in bad weather or rain. Ability of Data Patterns to offer the solution at lower cost places them in unique position for offering this solution in the global and domestic market.

The demand for gyroscopes is growing at CAGR of 11.25%, growing from $524.88 Million in 2021 to 1.37 billion in 2030. Key application for 0-15Kg mass class Earth Observation and demand is highest from Europe and Asia Pacific. With its experience working with key players in the region Data Patterns is positioned well to address the regional and domestic demand.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
on-board computer	20.89	15.66	5.22	29.79	27.22	37.11	26.68	38.66	42.33	37.12	26.67	44.94	51.18
power electronics	0.92	0.68	0.23	1.08	0.97	0.85	0.40	1.13	1.07	0.85	0.39	1.19	1.13
Batteries	21.81	16.35	5.45	25.84	23.12	20.29	9.39	27.15	25.74	20.29	9.39	28.46	27.05
Transmitter	3.65	2.73	0.91	5.05	4.64	5.64	3.84	6.06	6.55	5.66	3.83	7.01	7.54
Receiver	3.65	2.73	0.91	5.05	4.64	5.64	3.84	6.06	6.55	5.66	3.83	7.01	7.54
Transceiver	0.99	0.73	0.24	1.56	1.45	1.93	1.45	1.84	2.17	1.94	1.44	2.30	2.45
Gyroscope	4.56	3.40	1.13	6.48	5.90	8.21	5.97	8.56	9.35	8.24	5.95	9.92	11.46
Magnetometer	0.29	0.18	0.06	0.44	0.37	0.50	0.42	0.47	0.56	0.54	0.38	0.59	0.67
Magnetic Wheels	2.86	2.13	0.71	4.30	3.96	5.29	3.89	5.27	6.00	5.31	3.87	6.35	6.98
Magnetotorquer	0.16	0.12	0.04	0.21	0.19	0.24	0.16	0.26	0.27	0.24	0.16	0.29	0.33
Antenna	1.05	0.77	0.26	1.41	1.27	1.54	1.05	1.69	1.80	1.56	1.03	1.93	2.11
GPS Receiver	1.52	1.13	0.38	2.16	1.97	2.74	1.99	2.85	3.12	2.75	1.98	3.31	3.82

Figure 50 - Indian Satellite Manufacturing Components Forecast (CY 2021-2030)

Note: CY 2018-2020 values are historical, and CY 2021-2030 vales are projections.

The demand for magnetometer is growing at CAGR of 12.24%. Highest demand is from 0-15 Kg mass class with key application being Earth observation and IoT/M2M. With its existing product developed Data Patterns is well positioned to address the demand for magnetometers. The demand for magnetic wheels and magnetorquers is growing at CAGR of 10.94% and 13.08% respectively. The demand for antenna is about $84.3 Million in 2021 and grows up to $278.34 in 2030 growing at a CAGR of 14.19% and Indian demand is growing at 4.58%. Data Patterns is well positioned in to compete in global market due to their experience in building subsystems and components and offering them at lower cost.

In total Data Patterns is uniquely positioned in global and domestic market to offer complete satellite solution due to their experience working with ISRO and private players. In addition, they have ability to scale the manufacturing quickly for serial production, thus being an attractive choice for satellite operators with satellite constellations, enabling them access to low-cost solution in shorter timeline.

Ground Stations

The demand for satellite ground station equipment is mainly driven by upcoming demand for satellite constellations being planned and launched. As the number of satellites increases the necessity to ground station capacity is increasing in-turn increasing demand for ground station equipment. Data Patterns product portfolio mainly includes antenna in VHF, UHF and S-Band, which is frequently used antennas for nanosatellites. Data Patterns experience working with ground station equipment positions it uniquely to offer products at lower cost and higher reliability suitable for the small satellite operators.

In addition, Data Patterns has experience of working on upgrades of 6 tracking radars for ISRO with contemporary Electronics and software algorithms. They have developed coastal surveillance radar for ISRO, which is the first in India. They have future ready products such as X-Band Doppler weather radar, C-Band Doppler weather radar and wind profile radar. With the experience of building the complete solution for weather radars, Data Patterns is well positioned to build similar solutions for domestic and international market.

Testing Equipment

Data Patterns has successfully built cable tester for Gaganyaan mission and delivered to ISRO in 2020. Other products developed include single axis and three axis test station for ring laser gyro and strain data logger system. ISRO requires various types of automated test equipment for development of its test benches for the Polar Satellite Launch Vehicle (“PSLV”) and Geo Stationary Launch Vehicle (“GSLV”). All the electronic systems on the PSLV and GSLV as well as some satellite subsystems are tested by ISRO using such ATE. A robust service network ensures uptime of all this equipment. Data Patterns is the only company in India to have developed these complex ATE modules and is well established to capture the opportunity.

Global and Domestic Demand for Indian Space Players

Satellite Manufacturing:

With multiple Indian space market participants supporting ISRO with serial production of satellites and related space hardware, the Indian market landscape has evolved such that it is now ready to integrate with the global space industry ecosystem, especially the satellite manufacturing value chain. Companies like Data Patterns being able to develop fully redundant small-satellites for ISRO and New Space startups indicate that the Indian space market is already equipped to support mega-constellation programs through relevant, cost-effective serial production capabilities, specifically focusing on small-satellites.

Ground Station Services:

With the rise of NewSpace startups and ISRO efforts covering small-satellites for LEO missions, the need for suitable ground station services will grow moving forward in India. This will be in sync with what is already a rising demand at the global level. Multiple international ground station operators will be expanding their ground station network and this will create the demand for suitable ground station equipment and related hardware. The Indian space industry participants having enabled ISRO for decades using indigenous capabilities already stand relevant and eligible to support such expansion plans with relatively cheaper solutions which will attract customers in the global space industry. Apart from the ground station operators, multiple constellation operators are establishing their own ground station infrastructure which will further add to the growing demand for ground station equipment globally.

*Space System Testing Equipment***:**

Serial production of satellites is a paradigm shift in the space industry and with assembly line style of manufacturing, testing and validation is expected to grow as well. Across functional and end-of-line testing, significant testing and validation activities are expected to be vertically integrated with the assembly lines and this will create opportunities for space system testing service providers. Satellite manufacturers installing serial production lines will rely on testing specialists to achieve their respective vertically integrated testing and validation capabilities. This will create the demand for specialized space system testing equipment across functional and end-of-line testing segments. While acoustics and vibration testing capabilities will remain prominent within the launch vehicle manufacturing industry, more opportunities will come from the satellite manufacturing domain for space electronics testing.

COMPETITION ANALYSIS

The Indian defence industry is rapidly evolving into a self-sustaining one with companies and DPSUs moving towards specialising into defence primes, integrators and component suppliers. Similarly, the space industry is expanding with new space participants offering services which were previously offered by ISRO such as launch services, satellite operations and downstream services. The shift is driven by national space agency transitioning from being the sole player offering end to end solutions to being an enabler for private space players.

Several prolific private sectors Defence Technology Industrial Bases (DTIB), including those in the United States and the United Kingdom, grew in stages with private companies starting out as suppliers to government majors and military research facilities. Over time component manufacturers evolved into integrators and later into solution providers (for eg: a company that used to specialise in developing RF components would build a complete radar system). And as defence primes developed independent platform building capability, this new "division of labour" within the industry became more streamlined and specialised, resulting in greater industry revenues and profit. Competition in the Indian defence industry is in a state of flux, but moving towards consolidation and specialisation. Moving forward DPSUs are focusing on specialisation and integration and subcomponent manufacture is being outsourced to the private industry, resulting in more opportunities for the latter segment. Driven by new policies and government initiatives that are more predisposed towards procuring equipment from the private sector, competitors that already have strong business relationships with DPSUs, DRDO and larger private defence companies, as well as the R&D and manufacturing capability to build end – to-end solutions are likely to emerge as winners.

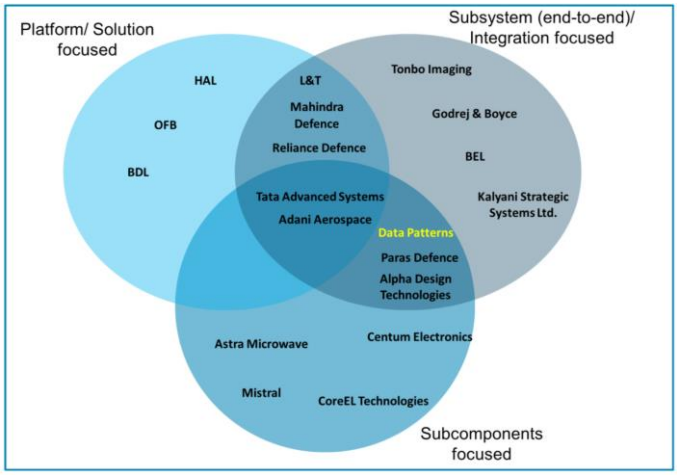


Figure 51 - Indian Defence Suppliers - Anticipated Future Positioning

The financial data of some Aerospace and Defence companies is as below:

Company	FY 2021			FY 2020			FY 2019		
	Revenues (INR Cr)	Net Profit (INR Cr)	Net Profit/ Revenues (%)	Revenues (INR Cr)	Net Profit (INR Cr)	Net Profit/ Revenues (%)	Revenues (INR Cr)	Net Profit (INR Cr)	Net Profit/ Revenues (%)
L&T[74]	73316	11337	15.46%	82384	6679	8.11%	82287	7491	9.10%
BEL	14064	2065	14.68%	12921	1794	13.88%	12085	1927	15.95%
Data Patterns	224	55.57	24.81%	156.1	21.05	13.48%	131.06	7.70	5.88%
Paras Defence	134	15	11.2%	149	19.66	13.19%	157	18.97	12.08%
Mahindra Defence Systems	Unknown	Unknown	Unknown	307.33	18.96	6.17%	285.00	32	11.23%
Tata Advanced Systems	Unknown	Unknown	Unknown	968.7	59	6.09%	511	34.06	6.67%
Astra Microwave Products	589	24	4.07%	462	47	10.17%	286	13	4.55%
Godrej & Boyce	9989	100	1.00%	11257	224.1	1.99%	11051	229.26	2.07%
Centum Electronics	823.3	13.1	1.59%	898.6	27.8	3.09%	937.5	48.4	5.16%
Alpha Design Technologies	Unknown	Unknown	Unknown	399	10.4	2.61%	281	49	17.44%
Adani Aerosapce & Defence Ltd.	1.99	-0.7	-35.18%	2.74	-1.77	-64.60%	Unknown	Unknown	Unknown
CoreEl Technologies	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	108.63	0.98	1%
Mistral	Unknown	Unknown	Unknown	142.91	12.26	8.58%	161.89	17.78	11%

Table 15 - Financial Data of Indian A&D Companies 1

[74] Standalone figures are depicted here, not consolidated group figures

Company Name	FY 2021				FY 2020				FY 2019			
	EBITDA	EBITDA Margin (%)	RoCE (%)	RoE (%)	EBITDA	EBITDA Margin (%)	RoCE (%)	RoE (%)	EBITDA	EBITDA Margin (%)	RoCE (%)	RoE (%)
L&T	7335	10	13	19	6940	8	16	13	7742	9	14	15
BEL	3181	23	28	19	2734	21	26	18	2865	24	32	21
Data Patterns	95	41.75	34.7	27	47	29.50	23.4	13.7	27	20.3	12.5	5.8
Paras Defence	Unknown				41.68	27.01	14.9	16	45.67	27.98	21.27	20
Mahindra Defence Systems	Unknown				528.28	16.6	13.4	6.6	267.72	9.3	7.2	12
Tata Advanced Systems	Unknown				191.5	18.52	3.96	0.3	25.5	4.84	0.47	0.2
Astra Microwave Products	66	11	9	4	90	19	13	8.5	33	12	4	2.5
Godrej & Boyce	Unknown				342.33	3.040822	3.458	1.5	355.88	3.22018	3.459	1.2
Centum Electronics	95.3	11.6	9.5	7.6	113	12.6	14.3	9.7	110.1	11.8	14.9	13
Alpha Design Technologies	Unknown				42.5	10.4	1.3	0.1	42.8	14.7	5.7	1.1
Adani Aerosapce & Defence Ltd.	Unknown											
CoreEl Technologies	Unknown								101.52	9.3454	15.83	3
Mistral	Unknown				22	15.12	16.03	12	24.83	15.05	24.44	19[75]

Table 16 - Financial Data of Indian Companies 2

- Astra Microwave, Alpha Design Technologies and Data Patterns have shown consistent increases in the three years whilst Centum Electronics revenues have dropped. Paras Defence's latest revenues are unavailable, but a revenue expansion over 2019-20 can be anticipated. Comparing the profitability of these companies as a percentage of revenues yields a clearer picture of company performance.
- Data Patterns' financial performance was unaffected by the pandemic as its net profitability soared by approximately 164% from 2019-20 to 2020-21 time frame, emerging as the company with the highest profitability growth among those

[75] EBITDA Margin is defined as EBIDTA/Net Revenues. Return on Capital Expenditure is calculated by dividing Earnings before Interest and Taxes by employed capital. Return on Equity is calculated as Net Income divided by shareholders' equity

compared above. During the last year Astra Microwave and Alpha Design Technologies witnessed a drop in profitability. It's also important to note that during the pandemic year the company's revenues grew by 43% (from 2019-20 to 2020-21), the highest among all companies covered in the analysis. The company's EBIDTA (Earnings before Interest, Taxes), Depreciation & Amortization margin, Return on Capital Employed and Return on Equity also were the highest during the same time-frame. This made Data Patterns as one of the fastest growing company in Defence and Aerospace Electronics sector in India with excellent margins and return ratios.

Competitor Profiles

Larsen & Toubro

Title	Brief
Background	L&T strongly diversified into the defence segment in the mid-1980s when the company started working with DRDO and on the naval modernization programme[76]. The company is at the forefront of the Indian defence industry and is quickly evolving into a capable defence prime, capable of developing and manufacturing end to end solutions for the military.
Capability Brief[77]	Major facilities include 1. Submarine hull-building facility and an Armoured Systems manufacturing, integration & testing facility at L&T's Hazira Complex (near Surat) 2. Modern shipyard at Kattupalli (near Chennai) 3. Aerospace manufacturing shops for rocket motors for India's Space Launch Vehicles at Powai and Coimbatore 4. Precision Manufacturing & Systems Complex for Aerospace & Missiles manufacturing at Coimbatore 5. Advanced Composites facilities at Vadodara and Coimbatore 6. Strategic Systems Complex for Weapon & Engineering Systems and Sensors at Talegaon near Pune • Strategic Electronics Centre at Bengaluru 7. L&T also operates a facility at Visakhapatnam under the Government Owned Contractor Operated (GOCO) model 8. R&D centres are present at Powai (Mumbai) and Bengaluru 9. Design and Engineering Centres are also present in Powai and Chennai.
Product Portfolio	1. Guns

[76] http://www.spslandforces.com/story/?id=623&h=LandT---Leading-Indigenous-Defence-Manufacturing-Through-Significant-Investments-In-RandD

[77] https://investors.larsentoubro.com/pdf/MDA%202019-20%20-%2003%20Defence%20Business.pdf

Title	Brief
	2. Armoured Systems 3. Missiles 4. Aerospace Systems 5. Avionics, 6. Sensors and Robotics 7. Submarines and Underwater Platforms 8. Weapon and Engineering Systems 9. Unmanned Systems 10. Radar Systems 11. Torpedoes 12. Rocket engine motors 13. L&T Valves: critical flow control solutions 14. Heat Shields.
Recent Reported Contracts/ Opportunities	1. One of two shortlisted for the Indian Navy's P-75A 2. Order for 54 fast interceptor boats (completed) 3. L&T, along with BEML and TPCL, has received orders from the MoD to supply 4 regiments of Pinaka Weapon Systems worth $350 million 4. L&T, in partnership with Hanwah, won a global competition to supply 100 units of K9 Vajra –T 155 at a price of $625 million 5. L&T was also recently awarded a US Government contract to build a supply vessel for Chile 6. L&T delivered S200 strap on booster for GSLV Mk III for Ganganyaan mission ahead of schedule in November 2020.
Relationships	1. Relationship with DRDO started with the naval indigenization programme 2. Partnering with DCNS to build Scorpene submarines in India 3. Joint venture with MBDA to develop weapon systems[78] 4. L&T and HAL consortium working with ISRO for manufacturing and assembly of PSLV.
Major Business Focus Areas	1. The focus is mainly on the Indian Naval and Coast Guard segment and the Indian Army 2. It has also entered the C4ISR and battlefield domains with regard to land forces. L&T was a key competitor in the much-delayed Battle =field Management System segment 3. Space focus is mainly on manufacturing and assembly of PSLV for ISRO and manufacturing key satellite components.

Bharat Electronics Ltd.

Title	Brief

[78] https://investors.larsentoubro.com/pdf/MDA%202019-20%20-%2003%20Defence%20Business.pdf

Title	Brief
Background	BEL was set up in 1954 to boost India's indigenous capability to produce defence electronics and solutions. The company, which was initially set up to develop basic communication equipment, today provided end to end C4ISR solutions. BEL works closely with DRDO and other Indian defence companies to build products currently fielded by the Indian Armed Forces[79].
Capability Brief	Major facilities include 1. Manufacturing unit in Bengaluru focusing on military communications, NCW, ISR solutions, EW, UAS and missiles 2. Facility in Ghaziabad focuses on sitcom, microwave components, radars, antennae and network systems 3. Centre in Pune focuses on UGVs, batteries, electro optics 4. Centre in Machilipatanam specialises in electro optics, especially Night Vision Devices 5. Panchkula facility production on tactical communication and encryption products 6. Facility in Chennai focuses on tank electronics and optronics 7. Kotdwara facility focuses on communications solutions 8. Hyderabad facility focuses on electronic warfare 9. Navi Mumbai facility focuses on homeland security systems
Product Portfolio	1. Communications solutions – SDR, SatCom, datalinks, nodes, encryption modules 2. Land based radars – surveillance, weapon-locating, fire-control, secondary surveillance 3. 3D Naval radars, missile defence radar, surface surveillance radar 4. C4ISR solutions 5. EW, ELINT, COMINT, SIGINT, MULTIINT solutions 6. Avionics 7. Optronics 8. Akash missile systems 9. Combat management systems 10. Simulators 11. Batteries 12. Sonar systems
Recent Reported Contracts/ Opportunities	1. Supplying ship-borne software defined radio solutions to the Indian Navy; contract executed in 2021 worth over INR 1000 Cr. 2. Supplying laser dazzlers to the Indian Navy for counter UAS operations.

[79] https://www.ddpmod.gov.in/defence-public-sector-undertakings

Title	Brief
Relationships	1. Major supplier to DRDO and ISRO 2. Have exported to various equipment to countries such as USA, Turkey, Israel, Singapore, Russia, Germany, Italy, France, UAE etc. 3. Has set up a JV with Thales to develop advanced radar systems
Major Business Focus Areas	1. End to end C4ISR solutions; however, the company is focusing more on product development and integration with the intention of outsourcing a large proportion of component/ subsystems manufacture.

Data Patterns

Title	Brief
Background	Data Patterns was established in 1985 as a defence electronics company and has evolved into end-to-end military solution provided. The company's extensive COTS capabilities have helped make the firm a critical supplier to DRDO, ISRO and several DPSUs. The company has been positioning itself through capability expansion and R&D advancements into a key supplier for most upcoming military projects in India, whilst also developing solutions with export potential. The company already supplies components to defence primes in South Korea and Europe.
Capability Brief	Major facilities include 1. Manufacturing, design and engineering facility in Siruseri infrastructure in Siruseri. The facility also caters to cabling, testing & evaluation, mechanical and display integration, avionics assembly and quality control.
Product Portfolio	1. Radar solutions – surveillance, weather and tracking radars 2. Platform electronics for land, air and sea 3. EW, COMINT and ELINT solutions 4. Communication equipment 5. Radar warning systems 6. Seekers for missiles 7. Cockpit displays 8. UAS 9. Fire control systems for missiles and torpedoes 10. Visual display units 11. Small satellites 12. Automatic testing equipment (ATE) 13. Ground station Antenna 14. Launch vehicle tracking radars 15. Weather radars

Title	Brief
Recent Reported Contracts/ Opportunities	1. Won an INR 380 Cr contract to install 9 precision radars in Naval and Air Force stations.
Relationships	1. Supplier relationships BEL, ISRO and DRDO 2. Supplier relationships with foreign defence primes
Major Business Focus Areas	1. C4ISR end to end solutions 2. Electronic Warfare 3. Weapons systems (seekers) 4. Satellites 5. Ground equipment 6. Automatic Testing Equipment

Paras Defence & Space

Title	Brief
Background	Paras Defence has been operating in the defence and space domain for 40+ years and is positioned as an IDDM company. The company has strong capabilities in C4ISR and in niche technologies such as EMP protection.
Capability Brief	Major facilities include 1. Has manufacturing facilities in Mumbai
Product Portfolio[80]	1. Heavy engineering solutions including flow formed tubes, titanium based manufacturing and radar cooling assemblies 2. Optics solutions including diffractive gratings, mirrors and optical domes 3. Military grade control systems 4. EW subsystems 5. EMP hardening solutions 6. Opto-electro-mechanical assemblies for satellites, nano satellites.
Recent Reported Contracts/ Opportunities	1. Unknown
Relationships	1. Supplier relationships with ISRO, DRDO, BEL, HAL, Cochin Shipyard, GRSE, BDL, Brahmos, OFB, IAI, Elbit Systems, Rafael Advanced Defence Systems, Safran, and L&T 2. Has a technology partnership with Holland Shielding Systems BV for EMP solutions 3. Partnership with HPS on development of space antennas

[80] https://www.parasdefence.com/project-profiles/

Title	Brief
	4. Partnership with Genesys Aerosystems for avionics suites 5. Partnership with Curtiss-Wright for turret stabilisation technologies 6. Partnership with DIEHL for counter-drone solutions
Major Business Focus Areas	1. C4ISR subsystems, EMP protection, EW and heavy engineering

Mahindra Defence Systems

Title	Brief
Background	Mahindra Defence Systems' major focus area is the production of armoured vehicles. Through its joint venture with Telephonics, the company also develops and integrates ISR equipment. The company also provides up-armouring services for clients, especially for those in the Middle East region.
Capability Brief[81]	Major facilities include 1. Special vehicles production facility in Faridabad 2. Centre in Pune that manufactures sub-systems, weapon systems with associated electronics, and related armament systems 3. Mahindra Telephonics has a manufacturing facility in Prithla, Haryana
Product Portfolio	1. Land Platforms – APCs, Light Tactical Vehicles, MRAP 2. Up-armoured vehicles 3. ISR equipment and defence electronics
Recent Reported Contracts/ Opportunities	1. Supplying 11 airport surveillance radars for the Indian Navy and Indian Coast Guard 2. Won a contract to supply 1300 light tactical vehicles to the Indian Army over the next 4 years[82] 3. Assembling and supplying M777 howitzers to the Indian Army[83]
Relationships	1. It has a JV with Telephonics Corp. US for developing radar and communication and surveillance equipment. 2. It has a partnership with GE and Magellan Aerospace for structural assemblies. 3. It has a JV with Airbus to make military helicopters. 4. It has a partnership with Ultra Electronics to manufacture underwater warfare equipment. 5. Has MoUs with ShinMaywa Industries Limited, Japan,

[81] https://investors.larsentoubro.com/pdf/MDA%202019-20%20-%2003%20Defence%20Business.pdf
[82] https://www.businesstoday.in/latest/economy-politics/story/defence-ministry-signs-deal-with-mahindra-defence-systems-to-procure-1300-light-combat-vehicles-291428-2021-03-22
[83] https://www.hindustantimes.com/india-news/m777-regiment-to-get-3-made-in-india-guns/story-xhNr4drnZCckqN3qErlfyK.html

Title	Brief
	manufacturer of Amphibious Aircraft US-2 amphibious aircraft and Aeronautics Limited Israel to manufacture shipborne UAS
Major Business Focus Areas	1. Major focus is on land platforms and radar systems 2. Secondary focus seems to be on ISR solutions 3. The company is keen to develop unmanned solutions as well

Tata Advanced Systems

Title	Brief
Background	Tata Advanced Systems is Tata Group's A&D focused establishment. The company is currently undergoing a consolidation to merge defence oriented verticals of Tata Motors and Tata Power Strategic Engineering Division.
Capability Brief	Major facilities include 1. Tata Sikorsky joint venture in Hyderabad 2. Tata Lockheed Martin Aero structures facility in Hyderabad 3. Homeland Security focused facility in Gurgaon 4. Facilities focusing on radar, EW, communication systems in Hyderabad 5. R&D division in Mumbai
Product Portfolio	1. Missile Systems and sub-systems 2. Radar Systems and sub-systems 3. Command & Control Systems 4. Aerospace & Aero-Structures 5. Unmanned Aerial Systems 6. Optronic Systems 7. Homeland Security Solutions 8. Satellite and launch vehicle components (solar panels, interstage assemblies, deck plates, adaptors)
Recent Reported Contracts/ Opportunities	1. Tata Power SED won a $243.1 million contract to modernise 30 IAF bases. 2. Tata Power SED, with L&T, is competing for the high-value BMS contract. 3. The company built control systems for the indigenous Arihant Class nuclear submarine. 4. Aurora Integrated Systems, a subsidiary of TASL, was awarded a contract by the Indian Army to supply 49 mini UAVs. 5. Airbus Defense and Tata Aerospace & Defence will jointly execute a project to equip the IAF with 56 C-295 transport aircraft in a deal worth $2.5 billion.

Title	Brief
	6. Lockheed Martin signed an agreement with TASL to produce the F-21 in India for MMRCA.
Relationships	1. It has entered into a JV with Sikrosky to manufacture approximately 4,000 helicopter cabin parts. 2. It has a JV with LM to manufacture aero structures. 3. It operates a 100%-owned subsidiary NOVA Integrated Systems Ltd., which will focus on missile systems, radars, UAVs, optics, and HLS. 4. It has a JV with ELTA Systems, Israel to collaborate on developments in radar, communications, and EW, homeland and surveillance systems. 5. It has a partnership with GE and Magellan Aerospace for structural assemblies. 6. Tata Lockheed Martin Aero structures Limited is a partnership between TASL and Lockheed Martin to produce the C-130J Super Hercules transport aircraft. 7. The firm has a partnership with Rockwell Collins to develop software-defined radio systems.
Major Business Focus Areas	1. UAS and other airborne platforms 2. C4ISR 3. Satellites

Astra Microwave Products

Title	Brief
Background	Astra Microwave Products was formed in 1991 as a solution provider in the domain of RF/Microwave/Digital electronics. The firm occupies segments in defence, home land security, space and civilian sensor domains. Several subsystems developed by the company are operational on Indian satellites in space.
Capability Brief	Major facilities include 1. Three production units and two R&D units that also include an exclusive space qualified facility[84] 2. Facilities are also capable of assembly and functional/ environmental testing
Product Portfolio[85]	1. Subcomponents for radars, EW and telemetry 2. Perimeter intrusion detection solutions 3. Meteorology solutions 4. Air traffic management radar solutions 5. Space Electronics
Recent Reported	1. Previous contracts included subsystem supplies to Israel

[84] http://www.astramwp.com/?page=about-us
[85] http://www.astramwp.com/?page=products&subcategory=44sub

Title	Brief
Contracts/ Opportunities	Aerospace Industries, and Italy's SIAE Microelectronica
Relationships	1. Bhavyabhanu Electronics Private Limited (BEPL) is a fully owned subsidiary focused on providing design, development, testing and evaluation of defence electronics 2. Aelius Semiconductors Pvt. Ltd is a Singapore based subsidiary that focuses on development of advanced semiconductors based solutions including those using GaN 3. Has a JV called Astra Rafael Comsys Private Ltd. (ARC) with Rafael Advanced Defence Systems to explore Make in India opportunities d in the fields of Tactical Radio Communication systems, Electronic Warfare Systems and Signal Intelligence Systems[86] 4. Working with ISRO since 2008 for multiple satellite missions.
Major Business Focus Areas	1. Major focus is on advanced microwave and C4ISR solutions

Godrej & Boyce

Title	Brief
Background	Godrej & Boyce is a tier 1 manufacturer of components in the space, aerospace and defence domains. The company started working with ISRO in 1985 and currently builds engines for India's major rocket systems. The company also builds airframes, and precision and hi-tech aerospace components[87].
Capability Brief	Major facilities include 1. Has a Centre of Excellence in Aerospace located in Mumbai 2. Precision engineering facilities in Mumbai
Product Portfolio[88]	1. Liquid propulsion engines 2. Thrusters for satellites 3. Composite materials 4. Airframes 5. Steering gears for naval vessels 6. Missile launchers 7. Counter-mine flailing systems
Recent Reported Contracts/	1. Suppliers of composites and precision engineering components that are used in LRSAM and Brahmos

[86] http://www.astramwp.com/?page=alliances
[87] https://www.godrej.com/aerospace-and-defence
[88] https://www.godrej.com/aerospace-and-defence

Title	Brief
Opportunities	2. Supplies missile engines to DRDO/ BDL 3. Won a $ 30 million contract to supply parts for Rolls Royce engines[89]
Relationships	1. Business relationships with ISRO, DRDO and DPSUs 2. Supplier relationships with Honeywell, GE, Rolls-Royce, and Boeing
Major Business Focus Areas	1. Rocket engines, airframes and precision engineering components

Alpha Design Technologies

Title	Brief
Background	Alpha Design Technologies is a firm that is currently evolving from producing subsystems for the military equipment to developing solutions. The company has been involved in platform upgrades, including supplying Missile Launch Detection Systems for Mi-17 helicopters, Interrogator Friend/ Foe detectors etc. The company provides equipment and upgrade services for all three branches of the Indian Armed Forces. Adani acquired Alpha Design Technologies in 2019[90].
Capability Brief	Major facilities include 1. Assembly lines for opto-electronics, microwave subsystems, communications solutions and machining in Bengaluru 2. Creating a new satellite manufacturing facility with ISRO's help
Product Portfolio[91]	1. Optronics & LRF Based Products 2. Laser Aiming Systems 3. Thermal Imagers & Fire Control Systems 4. Navigation Systems 5. Tactical Communication 6. Radar and C3I Systems 7. EW Systems 8. Simulators 9. Microwave Components & RF Units 10. Aerospace 11. Ground equipment: Rail Mass Terminal (SATCOM transceiver module), Power Module Unit, Indian Rail Navigator 12. Very Small Aperture Terminal (VSAT) 13. Antenna Control System (ACS)

[89] https://www.industr.com/en/godrej-aerospace-launches-a-centre-of-excellence-to-enhance-manufact-2327504

[90] https://www.thehindubusinessline.com/companies/adani-enterprises-arm-acquires-alpha-design-technologies/article26899360.ece

[91] https://www.adtl.co.in/about

Title	Brief
	14. Satellite manufacturing and assembly.
Recent Reported Contracts/ Opportunities	1. Currently upgrading Pechora missile and radar systems for the Indian Air Force. Upgradation covers Radar Transmitter, Thermal Imager-based Electro-Optical System, Communication equipment, upgradation of drive chain, Control Cabin, Shelters, Cables, etc[92] 2. Manufacturing 500 VHF communication devices in partnership with Elbit Systems to cater to requirements of the armoured corps 3. Consortium of Alpha design technologies, BEL and Tata to deliver assembly of 27 satellites for ISRO.
Relationships	1. JV with Elbit systems for manufacture of equipment and sub-systems, assemblies, components and manufactured parts for Opto-electronics, Tank Upgradation Programs, UAVs, EW Systems, Communication Systems, etc[93] 2. JV with Elettronica, Italy, for production of Phased Array Jammers 3. The subsidiary, Alpha-Tocol, manufactures aerostructures and is a supplier to HAL 4. Contract with ISRO for manufacturing satellites, establishing satellite manufacturing, integration, testing and qualification facilities.
Major Business Focus Areas	1. Major focus is twofold – 1. Development of RF based solutions for EW, communications and ISR solutions for the military. 2. Development of subsystems and eventually full satellites and ground systems as per ISRO's requirements 3. Advanced aerostructures

Adani Aerospace & Defence Ltd.

Title	Brief
Background	Adani accelerated its foray into defence after the initiation of the "Make in India" initiative and has nurtured defence relationships with several defence primes such as Saab over the past five years in order to position itself well for future contracts. The company is focusing on both production of subcomponents and development of platforms and has been expanding its capabilities through acquisitions. The Group, together with Israel Weapons Industries (IWI), acquired

[92] https://www.adtl.co.in/news/upgrading-pechora-surface-to-air-missile-system-indian-private-firm-alpha-design-wins-rs-591-crore-contract
[93] https://www.adtl.co.in/joint-venture-subsidiaries

Title	Brief
	Gwalior based PLR systems to acquire small arms production facilities[94]. The company had also acquired Alpha Design Technologies in 2018 to acquire EW/ microwave electronics capabilities.
Capability Brief[95]	Major facilities include 1. Systems, Avionics & Aerostructure production facility in Bengaluru 2. Air Defence cluster in Mundra 3. UAV R&D, assembly, and manufacturing unit in Hyderabad 4. Small arms manufacturing facility in Gwalior 5. MRO hub in Nagpur
Product Portfolio[96]	1. Radar subsystems 2. Defence electronics 3. Transmissions for land platforms 4. Electro-optics 5. Aerostructures (metal and composite) 6. EW 7. UAS/ Counter-UAS 8. Small arms 9. Simulators 10. MRO 11. Missile systems 12. Space systems
Recent Reported Contracts/ Opportunities	1. Adani is competing for a major UAV replenishment programme of the Indian Armed Forces 2. Adani has a tie up with Saab to compete for future fighter recapitalization programmes of the Indian Ari Force
Relationships	1. Strong relationships with Israeli defence enterprises – Elbit Systems for UAS and IWI for small arms 2. MoU with Airbus for collaboration on aircraft services 3. Has a tie up with Saab to manufacture the Gripen in India (potentially predicated on IAF choosing the Gripen for future recapitalisation)
Major Business Focus Areas	1. Integration and development of MALE and tactical UAS 2. Small arms and missiles production 3. Establishing an MRO hub in India for commercial aircraft and helicopters 4. Subsystem development – C4ISR 5. Training and Simulation

CoreEL Technologies

[94] http://plrsystem.in/
[95] https://investors.larsentoubro.com/pdf/MDA%202019-20%20-%2003%20Defence%20Business.pdf
[96] https://reports.adani.com/Adani-Defence-and-Aerospace/index.html

Title	Brief
Background	CoreEL Technologies was founded in 1999 and focuses on design and development, prototyping, digital products, Integrated solutions, volume manufacturing, obsolescence management, COTS products and semiconductor solutions for defence and security applications[97].
Capability Brief	Major facilities include 1. Has a manufacturing, testing and quality assurance facility in Bengaluru
Product Portfolio[98]	1. Product portfolio mainly consists of subcomponents for radar, EW and sonar systems. End to end solutions developed are limited, however the company produces several advanced subcomponents – including, Exciters and Receivers for AESA radars.
Recent Reported Contracts/ Opportunities	1. Unknown
Relationships	1. Unknown
Major Business Focus Areas	1. Major focus is on advanced defence electronics such as beam forming technology.

Centum Electronics

Title	Brief
Background	Centum was founded in 1993 and has carved a niche for itself in several applications within electronics, including defence, space, aerospace, communications, energy, medical, transportation and automotive[99]. The company has three business segments – Engineering R&D services, Electronic Manufacturing Services, and Build to Specification services.
Capability Brief	Major facilities include 1. Has a manufacturing, testing and quality assurance facility in Bengaluru. The facility has a broad swathe of testing and evaluation services, and is capable of design, development and manufacturing of electronics products. 2. The company also has a manufacturing facility in Canada

[97] https://www.coreel.com/about-us
[98] https://www.coreel.com/products/aerospace-and-defence
[99] https://www.centumelectronics.com/group-profile/

Title	Brief
	and a design department in France
Product Portfolio[100]	1. Within defence, the group focuses on electronic subsystems for missiles, EW, communications and fire control systems 2. For the commercial aviation sector, the company develops UPS, embedded computers, inverter modules etc. Several tier 1 aircraft manufacturers are among the company's clients 3. Satellite bus systems, test tools, power management systems, LRU and Data Recorders.
Recent Reported Contracts/ Opportunities	1. Major supplier of defence subsystems to the DRDO and ISRO
Relationships	1. Business relationships with DRDO, ISRO and defence PSUs. Relationships with private Indian and overseas defence primes unknown
Major Business Focus Areas	1. Major focus is on advanced defence electronics and testing. Limited focus on developing end to end solutions

Mistral

Title	Brief
Background	Mistral focuses primarily on design and development technology solutions[101]. The company focuses both on solutions for defence and homeland security.
Capability Brief	Major facilities include 1. R&D/ manufacturing facility in Bengaluru
Product Portfolio	1. Radar modules 2. COTS boards and software 3. Bespoke processing boards
Recent Reported Contracts/ Opportunities	1. The company sells bespoke solutions to DPSUs 2. It has sold electronics equipment (such as geolocation modules) to US defence companies
Relationships	1. Company has strategic alliances with Qualcomm, Texas Instruments, Microsoft, NXP, Wind River, Curtiss Wright Defense Solutions, and Ansys[102]
Major Business Focus Areas	1. Focus is mainly on electronics subcomponents 2. Recent forays include the UAS segment and converging AI and machine learning into homeland security solutions

[100] https://www.centumelectronics.com/our-sectors/defence/
[101] https://www.mistralsolutions.com/about-us/
[102] https://www.mistralsolutions.com/about-us/alliances/

Product Capability Comparison

F&S' comparison of key product related capabilities that will drive Indian defence programmes revealed that Data Patterns has strong and balanced capabilities across the 12 segments considered. The company is poised to take up emerging opportunities to build India's defence and space related capabilities.

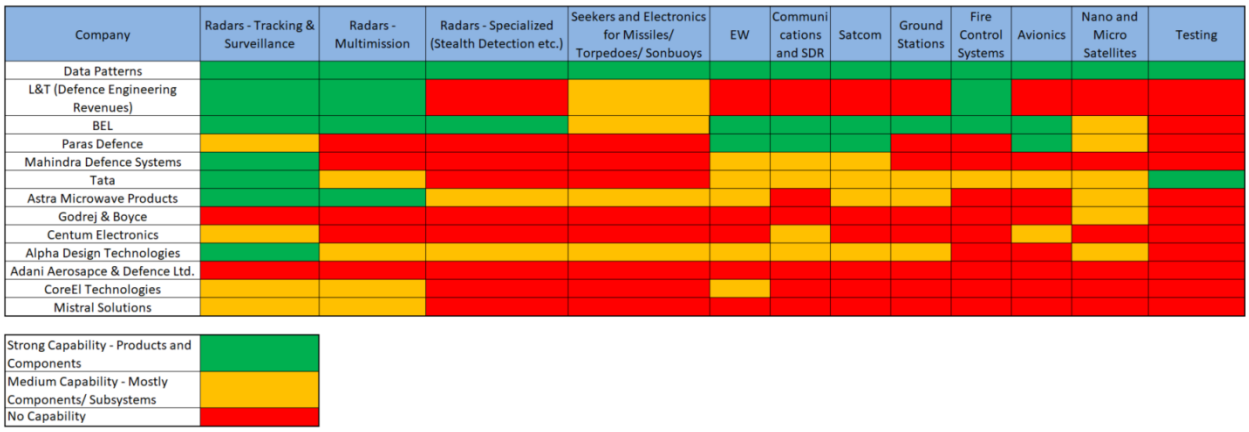


Figure 52 - Product Capability Comparison of Major Indian Defence Stakeholders

- Data Patterns has 100% in house design, development and manufacturing capabilities across the segments depicted in Figure 51. The company has over 30 years of experience in the industry and is among the few truly vertically integrated end-to-end operators in the Indian defence industry.
- Its strong antecedents producing building blocks of technologically complex products for the DRDO and DPSUs over the years have given the company a strong foundation to build its own products.Data Patterns has design capabilities across the entire spectrum of strategic aerospace and defence electronics solutions including processors, power, radio frequency and microwave equipment, embedded software and firmware and mechanical engineering. It offers products catering to the entire spectrum of aerospace and defence platforms including space, air, land and sea. The company has end-to-end capabilities to build and deliver complete systems, with their design and manufacturing capabilities being completely in-house.
- As a proven supplier to defence primes in Europe and Asia Pacific, quality standards of the company's products have exceeded expectations. With a strong focus on COTS, the company produces 1000+ building blocks that can be used on multiple end systems in defence and space. It also has strong software related capabilities and can develop bespoke device drivers and firmware as required.
- As Data Patterns covers the entire spectrum of defence electronics, it is well positioned to take part in land, airborne and naval defence programmes of India. Several solutions, such as those in the company's radar systems portfolio, have

good export potential, especially to countries that seek a balance between capability and value. The company's manufacturing approach is process driven; utilising frameworks that enable it to rapidly shore up or reduce manufacturing as per customer demand variations. The manufacturing infrastructure is certified by international A&D OEMs.

- .Note that the company maintained high profitability, even during the pandemic year. The company is expected to be a major participant in at least INR 1500 Cr worth of contracts in the next 3 years. With a skilled workforce of over 450 engineers and other highly trained professionals with 15+ years of work experience, Data Patterns is poised to address emerging industry challenges and requirements.

As also mentioned in the modernisation programs and component forecast sections, Data Patterns is a strong contender/ supplier for the following programs:

- Arudhra Radar - Data Patterns won the Array Group Receiver Unit (AGRU) in competition with Astra for this program[103]. They are expected to supply approximately 55 units of AGRU/ Arudhra radar. This is likely to generate a revenue of ~$ 2 million[104] in the next 3-4 years based on the requirement projection of IAF
- Ashwini Low Level Transportable Radar (LLTR) - Data Patterns has been a partner in development of these radars as a single vendor including TR modules, AGRU, signal processor, etc[105]. Based on the size of the program and components cost benchmarking as per Frost database, the company is expected to realise revenue between $10-30 million in the next few years. The range will depend on whether Data Patterns wins the entire radar contract or the electronics components (Electronics is expected to cost 30% of the total deal value as benchmarked from various programs , and indicated earlier in the report
- Data Patterns has received single vendor orders from DLRL for development and supply of all of the COMINT search receivers, Direction Finder, Monitoring receivers for the Dharashakti program. This project is the development program for large EW requirement for Deserts and Plains and has been nominated to BEL. This places Data Patterns in a strong position to be an OEM for the entire receiver systems with likely revenues of $ 50 million on complete execution of the program.
- The expertise gained in the project would also position Data Patterns to cater for airborne COMINT and ELINT equipment for various upgrades such as MI 17

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103 https://saiindia.gov.in/uploads/download_audit_report/2015/Union_Compliance_Defence_Air_Force_Report_38_2015_annexures.pdf

104 The estimation is based on Frost contracts database which includes prices of radars, component globally and nationally

105 https://saiindia.gov.in/uploads/download_audit_report/2015/Union_Compliance_Defence_Air_Force_Report_38_2015_annexures.pdf

Upgrades, Dornier Upgrades, Aerostat upgrades, and any new rotary wing programs

- Data Patterns strong EW capability will also help them in supplying products for light weight EW requirements. There is a heavy requirement of such products as the mountainous borders are not adequately covered, and the same has been prioritised due to the increased geo-political tension with China and Pakistan in the North, and North eastern parts of India
- Data Patterns has delivered an airborne surveillance radar (all of the hardware) for helicopters and fixed wing aircrafts to Electronics and Radar Development Establishment (LRDE on) a single vendor basis. LRDE is expected to flight test this radar in the next few months, and will be likely inducted in Navy's Dornier upgrade and new helicopter programs.
- Data Patterns is also a part of the Radar Warning Receivers for the Airborne Early Warning System (AEW & C) to Defence Electronics Research Laboratory (DLRL)[106]. This has been fitted on the Embraer early warning radar developed by Centre For Air Borne System (CABS)

- The company is also likely to deliver Next Gen completely wide open for LCA Mk IA[107] and Sukhoi 30 platforms subject to flight testing. After flight testing, these can be fitted on the 83 LCA MK IA on order as well as the Sukhoi 30 upgrades (~ 270 numbers), attack helicopters, etc. The flight tests are planned in the next 2 to3 months on the LCA, and similar tests are planned on Sukhoi 30 later.

- Various departments of the armed forces, including the DRDO utilise ATE for validation of all the electronics on various platforms, including airborne electronic systems such as Mission Computers, Displays, Launcher, Complete Missiles, Laser Guided Bomb and Infrared Guided Missiles. Data Patterns is also likely to benefit from the testing requirements of defence equipment in addition to the space industry testing portfolio.

[106] https://www.newindianexpress.com/cities/bengaluru/2012/may/24/drdos-production-version-of-iff-system-ready-371040.html

[107] https://timesofindia.indiatimes.com/india/finally-orders-for-83-lca-mk-1a-signed/articleshow/80674414.cms