

Key Factors for Enhancing Technological Capability in Strategic Electronics in India: A Study

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Abstract: The dynamics of Defence Electronics in India is changing so rapidly due to changes in the eco-system of Strategic Electronics industry around the world. The dominance in this technology domain is mainly from advanced countries like US, France and UK in major Systems supplies besides significant growth at critical technologies in countries like Israel, Denmark, Turkey due to prevalence of dynamic innovation system. Till last decade, the production of strategic products and systems was in the hands of Defence Research and Development Organization(DRDO) labs, Council of Scientific and Industrial research(CSIR) labs, Defense Public Sector Undertakings(DPSUs) and Indian Ordnance Factories (IOFs) and have been involved in producing the products and systems via Transfer of Technology from DRDO labs in the form of Licensed Manufacturing(MoUs), as a part of Technology Development Programs related to System of Systems with key inputs from academic institutions like IITs, IISc etc. In this paper, the entire gamut of defense production with reference to strategic electronics has been studied and the data is presented from various publications, global research organizations in order to have an understanding where the Indian Strategic Electronics stands and various factors contributing to its success for becoming nodal center for research and development of such systems with a modest aim to increase the technological capability of the country in this area.

Keywords: Technological Capability, Convergence of Technology, Technology up-gradation, Emerging Technologies, Strategic Technology, Self-Reliance.

1. Introduction

Defence Electronics is dominated by many technologies in the last decade and is mainly due to advances in artificial intelligence, machine learning, embedded system engineering, cognitive intelligence, cloud computing, data analytics, perception engineering, system simulation & modeling technology domains. As a result, the entire eco-system in managing the high technology in an enterprise is not restricted its own boundary and forced to depend upon other partner agencies, having right core competency in the select areas.

2. Technological capability and it's road map for defence production in India

A. Definition

Technological Capability [1], [2] can be defined on perspective of a nation [1] is that “complex array of skills, technological knowledge, organizational structures, required to operate a technology efficiently and accomplish any process of technological change”. The intended Technological Capabilities (TCs) embody the required resources required to manage and update the generation of technical change. Further, these resources are accumulated and embodied in skills, knowledge, experience and organizational systems and procedures [2].

B. Need for technological capability in defence sector - strategic electronics

1) Evolution of electronic industry in India:

Technological Capability in the field of strategic electronics has been ignored during last five decades as the electronics manufacturing has become reality with inception of a business entity, Bharat Electronics Limited in 1954 to support the strategic needs of the country. This is followed by ECIL, Department of electronics could pave a way for Electronics Manufacturing System (EMS) industry for the first time in India in the year 1990. Brief evolution of electronics industry in India is shown in Fig. 1.

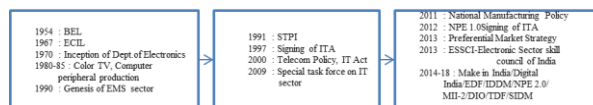


Fig.1.Evolution of Electronics Industry in India

As depicted in the Fig. 1, the electronics industry has taken many changes and the fact is that most of the strategic electronics is still dependent on imports from advanced countries due to non-availability of core technical skills. Despite many policies and programs of national importance, the strategic electronic industry could not pick its momentum due to poor manufacturing eco-system.

2) *Dominant technologies in defence electronics- convergence of technologies*

3) *Definition*

Convergence of Technology: It implies “the process of integration of a number of disparate technologies or functions into single integrated system”. On this basic concept, all the technologies around the electronics domain are being built.

C. Introduction

Electronics plays a vital role in producing the state of the art technologies for strategic needs for defence forces due to various uncertainties arising out of requirements /specifications, timelines, involvement of different partner, complexities in technology realization and involving high costs. As the entire doctrine behind the warfare has been changed due to various advances that took place in strategic electronics in the last one decade and mainly due to this, all the conventional practices of warfare has changed its position to SIGNINT(Signal Intelligence) so that whoever possess the more intelligence on the given context will have probability of success. Hence there is a lot of technology push in strategic electronics area in various domains.

List of dominant technologies: Some of the technologies, which are changing the electronics domain, are mentioned as below:

- Tactical Communication Systems-C4ISR systems- Immersive Surveillance, Battlefield Management System (BMS), Artillery Command, Control and Communications System (ACCS) and Air Defence Control and Reporting System (ADC&RS) all integrated through the Command Information and Decision Support System (CIDSS)
- Remotely Operated Vehicles/ Unmanned Aerial Systems- UAVs/Drones
- Electronically Scanned Array Radars
- Infrared based Imaging Systems- IR Detector(both cooled & uncooled)
- Cloud Computing and Data Analytics
- Future Infantry Soldier as a System(F-INSAS)
- Modern Sensors for Military Applications viz., Radars(SAR),Satellites (Earth Observation), IR sensors/Active Sensors for IR seeker for Missiles, Smart Sensors/MEMS/Nano/Wearable etc.
- Intelligent Security Systems- Intrusion Detection systems
- Electronic Warfare Systems-Jammers, Airborne platforms, Spectrum Warfare (Electronic-Cyber-Optical), IFF, Cognitive/Autonomous EW systems, Directed Energy Weapons, SDR based EW, Frequency agile EW systems (Anti Frequency Hopping) techniques. Convergence of COMINT and ELINT, EW with Air Defence Systems (Anti-Radiation Missiles).

1) *Defence spending scenario on a global level*

During the year 2017, the global spending amounts to USD 1.74 Trillion [3] and advanced countries like USA, France, Germany and Russia are spending in Defence equipment to increase their capability in all emerging technology areas. On global scale, ten countries viz., USA, China, Saudi Arabia, Russia, India, France, UK, Japan, Germany and South Korea spending amounts to 73% of global spending in the year 2017. The global spending in military technology sector is shown geographical area wise (Fig. 2.), indicating the military expenditure as of GDP.

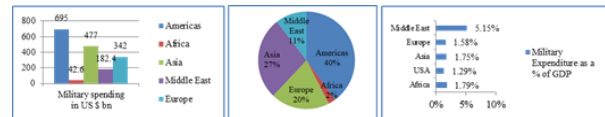


Fig.2. The global spending on defence technologies (source: sipri.org)

India being the largest importer of defence equipment in the world and with share of military expenditure of \$ 63.9 billion which amounts to global share of 3.7%. On global ranking , there were four organisations, viz., BDL,HAL,IOFs and BEL from India adding value to the defence production with percentage of sales of 100,96,94 and 86 respectively.

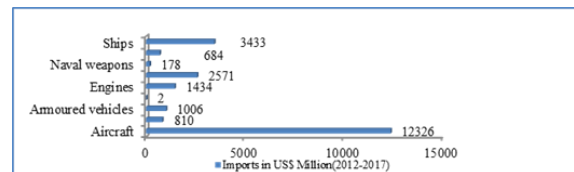


Fig. 3. Defense Imports & Sales with global ranking in defence production (source: sipri.org)

2) *Share of defence electronics in defense manufacturing*

The defense electronics is the key behind every system that is being produced across the boundaries due to rapid progress in IT, mainly referring to areas like artificial intelligence, robotics, machine learning, open computing languages, cloud computing, data analytics etc., and this is the area, which is making the warfare more complex and strategies for devising the systems also became a challenging environment for scientists and engineers. The sales from India are increasing year on year and the same is depicted along with the status of strategic electronics production in Fig. 3, which shows there is huge demand in the field of defence electronics as most of the platform electronics is taking shape as a part of defense modernization plans of tri-forces. Similarly, the Indian defense budget, as shown in Fig. 4, is also indicating that expenditure outlay is having the increasing trend year on year but the percentage increase is not commensurate with the futuristic technological programs for the armed forces. This is mainly due to ageing technology when compared to the other advanced

countries like USA, Russia, France, Germany, and Japan. Hence, thrust upon technological readiness is the need of the hour to improve the capability in defense electronics.



Fig. 4. Defence Budget YoY (Source: MoD Annual reports)

It is also evident that the defence budget mainly comprises of capital and revenue (shown in Fig. 5), meant for new acquisitions and up-gradation of systems, which is not earmarked for the strategic needs of the country due to many reasons and the budget projections with reference to the inflation over a period of time is shown in Fig. 6.

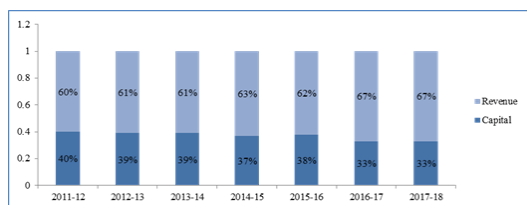


Fig. 5. Capital vs. Revenue Defence Budget YoY (Source: MoD Annual reports)

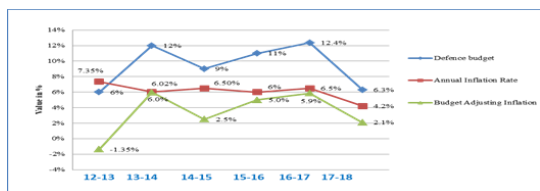


Fig. 6. Defence Budget & Inflation (Source: Union Budget reports)

During the recent budget 2019-20, an increase of 6.85% over the last year's budget has been proposed, which works out to Rs.3,18,770. As per the reports, the budget is not meant for meeting the capital acquisitions in pipeline and in real sense, this budget has gone down and is not even catering for inflation. Hence, the defence budget need to be realistic and accurate from the modernization point of view, for bringing a confidence in the minds of armed forces.

D. Technology capability requirements for armed forces-strategic electronics

The modernization process of the Indian armed forces has been explicitly spelt out in the Long Term Integrated Perspective Plan (LTIPP), covering the period up to 2027. As stated earlier, the pace of modernization of Indian armed forces has been slow, and technologically, they are not where they should have been. There are many concerns on emerging technology fields viz., Artificial Intelligence, Robotics, Nano Technology, Soft-skill weapons etc. Also, the basic research in all these fields is in a nascent stage of development. Quick look at these areas is needed to produce the systems of world class standards. A summary of various technological developments

envisaged by Indian Armed Forces in consultation with the Army Design Bureau, specific to Electronic Systems is depicted in Table 1.

Table 1
Technology Requirements in strategic electronics

Systems	Technology	Requirement	References
Tactical Communications	Command, Control, Communication, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR)	ARMY: Software Defined Radios in Mobile Ad-hoc network, environment, Battle Field Management System(BMS), AR based systems & Simulators, Network Centre Systems NAVY: Thermal Imaging Systems NAVY: Communication Satellite VLF, VLFHF, HF frequency range, Advanced Data Link Programme AIRFORCE: Flight Management System(FMS), Fly by Wire and Fly by Optics systems	LTIPP India Naval Indigenization Plan 2014-2030, Indigenization Roadmap of Indian Air Force (2016-2025) and Technology Perspective and Capability Roadmap (TCR)-2018
Advanced Radar Systems	Solid State Electronics	ARMY/NAVY: Multifunction Phased array radar, Synthetic Aperture radars(SARs), Low Probability of Intercept Radar(LP/PI), Millimeter Wave Radar(MWR)	
Advanced Sensors	Microwave, IR, Laser, MEMS, Photonics based	Various systems of Defence forces in electronics warfare, Seekers, Missile Guidance Systems, Directed Energy Weapons(Lasers, MEMS, High power microwave based)	
Unmanned Aerial Systems	Artificial Intelligence, Robotics, Signal Processing algorithms	UAVs for all three forces (Remotely Operated Vehicles, submersible vehicles, drones etc.)	

1) Strategic electronics production in India

The strategic electronics production in India [10] is taking shape to utilize its full potential out of various initiatives from Indian government. The growth in the production in case of strategic electronics is shown in Fig. 7.

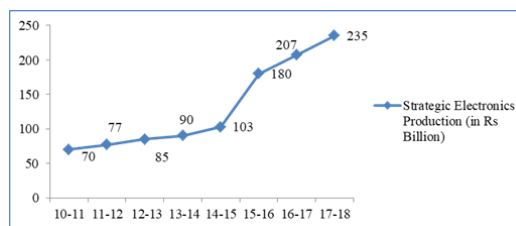


Fig. 7. Strategic electronics production (Source: MeitY reports)

Table 2
New start-ups in strategic electronics in India.

Company	System Development	Technology Area
Tonbo Imaging, Bengaluru	Sensor Systems, Imaging Products for Battlefield modernisation, immersive surveillance.	Advanced digital image processing & Sensor Systems (micro-optics, low power electronics)
IdeaForge, Mumbai	NETRA- man portable unmanned aerial vehicle(MUAV)	Artificial Intelligence & Robotics
Aadyah Aerospace, Bengaluru	Electro mechanical actuators, Electro optics based systems for missile launchers	MEMS based transducers/Electro-Optics
CRON Systems, New Delhi	Smart Fencing System	Intrusion detection systems
Aurora Integrated Systems, Bengaluru	Unmanned Aerial systems	Artificial Intelligence & Robotics
TimeTooth Technologies, Noida	Landing gear for UAV Rustom-II	MEMS
VizExperts, New Delhi	Data Analytics for armed forces(GEORBS)	Digital Sand Model- 3D geospatial system

The Indian strategic electronic industry [8], [9] is dominated by Bharat Electronics Limited (BEL) and has some contribution from Defence Public Sector Undertakings (DPSUs) such as Hindustan Aeronautics Limited (HAL), Bharat Dynamics Ltd, and central PSUs like the Electronics Corporation of India Limited (ECIL) and Central Electronics Laboratory (CEL). In the recent past, a few domestic small and medium scale companies have emerged as they have the capability to absorb technology and meet the stringent requirements of strategic equipment. So far, defence electronics industry in India has been growing at an average rate of about 13.4% per year. With the infusion of emerging technologies in information and communication technologies (ICTs), this area is expanding with a new focus on cyber warfare and its security. Many companies have started their foray into this domain becoming a part of many inventions in emerging fields like artificial

intelligence and cloud computing etc., which in turn, helping DRDO, DoS, DAE, and DPSUs in realizing the strategic needs of the country. A list of new startups [5], [8] in defence manufacturing, working on critical technologies is shown in Table 2.

In the coming years, Indian Defence experiences an exponential growth in strategic electronics systems due to thrust on developing technologies in both platform as well as non-platform based strategic electronics programs.

2) *Status of strategic electronics in defense manufacturing*

There has been an increasing trend in the defence production from the DPSUs and Indian Ordnance Factories (IOFs), [3] as shown in Fig. 8.

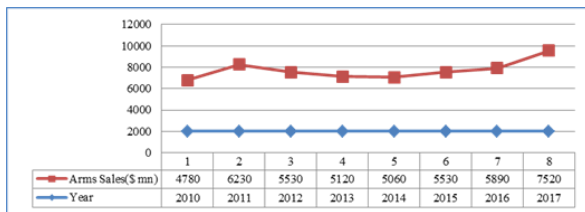


Fig. 8. Defence Sales (2010-2017, IOFs, HAL, BEL, BDL) (source: sipri.org)

Also, it is pertinent to note the fact that although India is now aiming for a substantial indigenous defence industrial base, only 0.9% of the Government’s total expenditure has been on R&D for this sector, which is considerably lower than most other countries. The R&D spending as a % of GDP [5], [7] is shown in Fig. 9., which is an indicator for emerging innovation system for defence electronics systems.

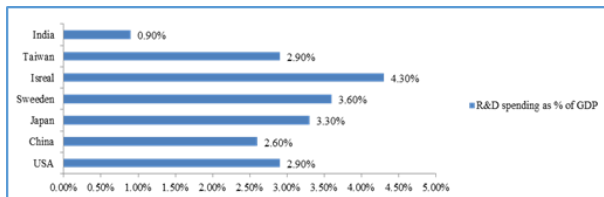


Fig. 9. R&D spending as a % of GDP (ELCINA, NITI AYOJ)

Appropriate budget allocations are the need of the hour. With the intent of promoting indigenous production of defence equipment and investment in new technologies, the government has announced various initiatives to give an impetus to this industry. Some of them are Indigenously Designed, Developed, and Manufactured IDDM- Buy Indian (2016), Foreign Direct Investment (FDI-2016, 49% and upto 100% through Govt. route), National Policy on Electronics-2.0(NPE-2018) etc.

3. Major Key players in strategic electronics industry in India

In the defense manufacturing, the technologies in micro-electronics and information technology are going to change the modern warfare by harnessing the power of embedded electronics, which, in turn, will make the defence electronics industry, mainly comprising aerospace and defence (A&D), a vibrant sector over the next one decade.

India, being the 7th largest aerospace and defence (A&D) market globally, country’ defence budget is sizeable and covers the requirements of the armed forces. As per reports, around 68% of defence equipment need modernization by addressing obsolescence as well as building additional capabilities through new capital acquisitions and up-gradations through revenue mode. However, the defence electronics industry’s ecosystem has evolved significantly in the last couple of years, with respect to the implementation and amendment of government policies related to defence procurement, as well as the foreign direct investment regulations. The major stakeholders in defence electronics capability spectrum is depicted in Table 3 [8].

Table 3
Key players in strategic electronics (Source: MoD, IDR reports)

Segment	Major Key Players
Missile Electronics	BDL,BEL,HAL,Alpha,Kalyani Defence,L&T, Mahindra Defence, TASI
Avionics	BEL,HAL,ECIL,L&T, Mahindra Defence, TASI
Strategic Components(MEMS,ASIC,FPGA,MW tubes, Crystals, HMCA,RF & Microwave)	MTRDC,BEL,CEERISAMEER,ECIL,Astra Microwave,Centum Electronics,Kalyani Defence, Rangsons,IComm,Avantel,Data Pattern.)
Electronic Warfare Systems	BEL,HAL,ECIL
Electro-Optics	BEL,HAL,Alpha Designs, TASI, L&T
Underwater Communication Systems(SONARS)	BEL,NPOL,NSTL,Keltron,Reliance,L&T
Multi Function Display Systems/Consoles	BEL,HAL,SAMTEL, Data Patterns,Alpha Designs
Tactical Communication Systems(C4ISR, SDRs,BMS)	BEL, HAL,ECIL, L&T, Mahindra Defence, TASI,Wipro
Advanced Radar Systems(AESA)	BEL,LRDE,Astra Microwave,Kalyani Defence,L&T, Mahindra Defence, TASI
Homeland Security	BEL, ECIL,TASI
Unmanned Aerial Systems	BEL,HAL,NAL,TASI,WIPRO,L&T
3D Printing Additive Manufacturing	IISc, Wipro
Chip Design & Manufacturing(Shakti)	IFT-MSCIL(ISRO)
Sensors	BEL, HAL, ECIL

A. *Future dominant technologies in defence platform electronics*

Table 4
A & D projections till year 2025 (source: MoD, IDR reports)

A&D projections till 2025	
Imports(Buy-Make category)	Approx.Value(In Rs Cr)
Medium Multirole Combat Aircraft(MMRCA)	42000
C-17 aircrafts	25000
Mirage Upgrade	10000
Helicopters	10000
Missiles(Javelin,MBDA MICA,Short & Medium range STAs)	7000
Total(a)	94000
Indigenous category(IDDM)	
Missiles(b)	103600
Aircrafts	
Light Combat Aircraft(Army,Navv, Airforce)	57000
Fifth Generation Fighter Aircraft(FGFA)	30000
Airborne Early Warning Control(AEW &C	2000
Airborne Warning and Control System(AWACS)	6000
Unmanned Aerial Vehicles(UAVs)	2000
Rockets	1100
Tanks	3000
Integrated Electronic Warfare Systems(IEWS)	1500
Advanced Radars	7000
Naval Systems	1200
Electro Optic Systems(EOS)	1000
Total(c)	111800
Helicopters	
Advanced Light Helicopter(ALH)	8000
Light Combat Helicopter(LCH)	5000
Total(d)	13000
Grand Total(a+b+c+d)	322400

As stated earlier, modernization of defence equipment is on anvil and most of the platform electronics due to capital acquisitions of modern weapon systems is becoming a boon to strategic electronics and it is expected to reach USD 72

billion(Rs.5.11 lakh Cr) by 2020 [7]. The major systems are depicted in Table.4. Key players for these systems considering the Public-Private Partnership model, the dominant role still lies on DPSUs with a collaborative approach with the major A&D private players like Tata Power SED, L&T, Wipro, Mahindra Defence, Bharat Forge, Reliance Naval, Astra Microwave, Alpha Designs, and Centum Electronics etc. The probable manufacturing clusters in manufacture of various advanced platform electronics are shown in Table 5.

Table 5
 Future clusters of manufacturing in A&D business
 (Source: MoD, IDR reports)

Product/System	Key Players
Missiles (Hypersonic and sub-sonic cruise missiles, Long range ballistic missiles with MIRV(multi- platform – land, air, under-water), Ballistic & Cruise missile defence systems with space segment, Multi-platform tactical missiles & missile based Precision Guided Munitions(PGM's).	RCI, Brahmos, BEL, BDL, Mahindra Defence, Kalyani Group- Bharat Forge
Naval Systems (Torpedoes with thermal engines)	NPOI, NSTI, BEL, Reliance Defence, Mahindra
EW Systems (Multi-platform EW systems, Cyber Warfare Systems)	DRDL, BEL, HAL, ECIL, Astra Microwave Products
Armaments & Combat Systems (Next generation MBT, APC, Remotely piloted reconnaissance ground vehicles, Low cost guided multi-barrel rockets with PGM's, Self Propelled guns with PGM's, and Futuristic Infantry Combat Vehicle(FICV))	IOFS, BDL, BEL, ECIL, Mahindra, Bharat Forge, TASI, Wipro
New Concept Weapons (Directed Energy, Lasers, High power Micro-wave, particle beams, Kinetic Energy, EM cannons, kinetic kill vehicle, Non-Anti Personnel, Chemical energy-losing agents, Low energy-laser blinding weapons, and Omni directional irradiation weapons)	LASTEC, BEL, MTRDC, IOFS
Aeronautics (UAV, UCAU, Aerostats, Airships with multiuse)	HAL, NAL, CAIR, ADE, ADA, BEL
Payloads (Multi role stealth combat aircraft)	

Most of the systems as mentioned in the Table 4 are of strategic importance and, with this, India will be able to assimilate the latest trends in defence electronics for setting up centers of excellence in the emerging technology areas. Most of the R&D centres in India has already started working on many of such technologies with dependence on foreign OEMs with reference to display systems, electronic modules, Sensors, Cables, Connectors, Advanced materials, Process technologies, Packaging techniques etc.

4. Key factors for enhancing the technological capability in Strategic Electronics in India

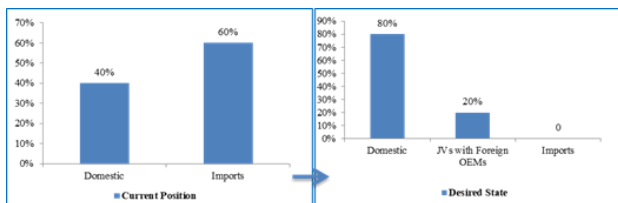


Fig. 10. Future space for Indian Defence manufacturing

In order to reverse the trend of imports and dependence on foreign OEMs, an eco-system is envisaged by considering the various factors viz., advanced products & systems, advanced processes & technologies on Industry 4.0 platform with convergence of technologies [4], which leads technology sufficiency in the area of strategic electronics. The current and

future imports envisaged by the Make in India-I & II are shown in Fig. 11.

To achieve the ambitious goal of achieving more domestic participation in defence manufacturing, mainly dominated by advanced raw materials, process technologies requires a concerted effort from all sectors Govt, DPSUs, private industry base existing in India. A model, as shown in Fig.12. has been proposed for maintaining an eco- system for defence manufacturing in reference to strategic electronics as the electronics plays a vital role in integrating system of systems in defence space.

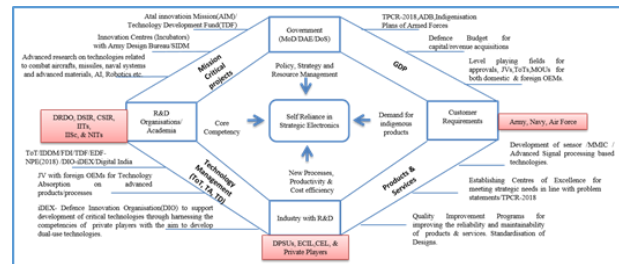


Fig. 11. A model for building technological capability in strategic electronics area

A. Challenges & Issues in Strategic Electronics

Factors for Consideration: Indian defence system is spearheading to build an eco-system involving various agencies from R&D, Industry, and Academia with suitable government initiatives to support both domestic and export demand yielding the material benefits to the industry and the country at large while meeting the customer expectations. Like other advanced countries viz., US, France, UK, Germany, India has to look at the capabilities to set right the Technology Innovation System. There are many factors to affect the technological capability in India and the same are mentioned below:

- **Choosing core capabilities:** The core technologies required for the armed forces is to be focused by establishing eco system as shown in the Fig.12 above by exploiting the various capabilities established over decades of managing systems by DPSUs and defence R&D labs. This is possible with strong coordination among various entities.
- **Optimal Innovation System:** In the recent past, MoD has taken an initiative to start the Defence Innovation Organization (DIO), part of Innovations for Defence Excellence (iDEX) which encourages to develop various core technologies by the incubators, R&D labs in consultation with DPSUs. Development of Shakti processor is such example and is the first of its kind in the microprocessor technology for India, which going to help communication and defence sectors.
- **Industry Structure:** Creating a level playing field for all industries both from domestic and foreign origin for ease of doing business in the process of creating a vibrant defence electronics system.
- **Strategic Partnerships:** The strategic partnerships

with innovative firms, both at domestic and foreign origin will improve the technology base and there were many instances of JVs among DPSUs, Indian Private Firms and Foreign OEMs in developing critical technologies. E.g., JVs: Reliance & Dassault , part of fighter jets, Bharat Forge & Rafael for Missiles, BEL & NPOL for Sonars, Kalyani Group & Rafael for anti-tank guided missiles, Astra Microwave & Rafael for SDRs, and Wipro & IISc for 3D Printing etc.

- **Talent Management:** Proper use of India’s lowest cost base coupled with skilled pool of engineers & scientists will create an eco-system for developing core competencies for meeting strategic needs of the country.
- **Government Initiatives:** At domestic level, GoI started giving importance to Indigenously Designed, Developed & Manufactured products & services, by welcoming the participation of 7000 MSMEs (approx.) in defence contracts. Procurement policies are also made to boost this area. India imports about 60-62% of its defense equipment, spending close to \$6.5 billion (approx.) every year by restricting the defence manufacturing to only DPSUs & IOFs by way of “built to print” mode. In the recent past, private industry started participating in almost all categories and this model stands successful on many occasions viz., Sonars, Akash Missile Systems etc. If the same trend continues, the future outlook of defence electronics is shown in Fig. 13 [7]. Hence, there is a great responsibility lies with DPSUs and DRDO labs to involve MSMEs in more programs so that the indigenization, production of systems for A&D business will become a reality in near future due to huge fund earmarked, nearly Rs 80,000 Cr[10] in the next 4-5 years under Make I & II categories.

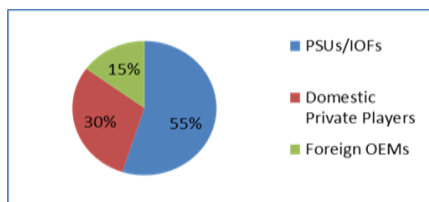


Fig. 12. Likely Market share of defence electronics (Source: MoD reports)

Fig. 13. On the export segment side, GoI with its persistent efforts and constant upgradation of its export control laws, could manage to enter into various memberships viz., Missile Technology Control Regime (MTCR) in June 2016, Wassenaar group in December 2017 and the Australia Group in January 2018. As India made an entry into Wassenaar Group, which will help Indian companies in dealing MoT of sensitive technologies.

Challenges & Issues in Defence Electronics:

- **Challenges:** There are many challenges in front of

defence eco-system and some of them are :

- Encouraging MSME base to be a part of National Defence Corridors. Viz., Tamilnadu & Uttarpradesh.
- Trying for more possibility of PPP in R&D.
- Producing modern weapon systems, combat aircrafts and radar systems in quickest possible time through domestic or foreign joint ventures or strategic partnering.
- Exploring offsets to accelerate the Indian Defence Industry to enable them to absorb the next generation technologies.
- **Issues:** The are many issues in realizing the modest challenges ahead of us in becoming self- reliant in the field of strategic electronics and some of the points are:
 - Fund availability for setting up of various institutions like DIO, Incubation centres etc.
 - Co-ordination and co-operation of entities from R&D, Industry and Academia with Army Design Bureau (ADB) for achieving the set goals.
 - Ease of doing business part of JVs and offsets through FDI route by managing Tier 2 & Tier 3 suppliers, who are going to manage and become critical in the supply chain.
 - Incentives as a part of new schemes in the form of TDF, upskilling manpower in order to absorb the latest technologies from foreign OEMs.

5. Conclusion

The technological capability [6] in strategic electronics is the sine qua non for developing state-of-the-art technologies in defence manufacturing segment. To meet this noble aim, GoI has taken major steps in the form of Make in India-IDDMM approach, where in indigenization could be the only panacea for all the problems we face today i.e, more dependency on advanced countries, high cost of imports, concentrating on low end technologies etc. In order to accelerate the innovation in defence electronics, TDF, part of Bharat Innovation Development Fund to encourage MSMEs/Startups to showcase their talents in the emerging areas of micro-electronics and IT areas. So far, DPSUs, IOFs and other Central PSUs have not progressed much beyond the licensed production and private sector was restricted to concentrate on sub-assy/module level production activities. Now, time has come for DPSUs and R&D eco system to concentrate on high end technologies, system integration while allowing the MSME sector to be a part of whole supply chain for supporting in all around development of mission critical technologies in close collaboration with R&D and Academia(Incubators) , which forms a vibrant eco-system for defence manufacturing, in particular strategic electronics segment, as most of the electronics is now dominated by modern technologies, emerging from IT and other electronic techniques viz., MEMS, Electro-Optics, Signal processing, Sonars, Radars etc. With increased participation of private players in defence manufacturing leads to self-reliance

in the field of strategic electronics, which in turn, increases the capability to advance on technology front, brings prosperity to the country.

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