JOINT C4ISR AND FUTURE READY FORCE

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Introduction

"War is but one of the ways of enforcing the political will of one nation upon another and is diplomacy by other means".

Since time immemorial, tribes and nations have waged wars and only the methods, means and morals of waging war have changed over a period of time. War fighting in olden times was a gentleman's business with strict rules of engagement being followed. However with the passage of time, these rules got diluted and attacks started being mounted at night and civilians, women, elderly & children also started being targeted. Over a period of times, wars saw tools and technology augmenting brawn and sheer brute force.

Rationale for Change & Imperatives to Usher in C4ISR

Organizations (including the Armed Forces) need to adopt certain aspects like radical adaptability, co-elevation, resilience and foresight, which are essential for an organisation to succeed in this new era. Radical Adaptability prompts an organisation to constantly anticipate change, reinterpret it, and transform through change. This concept is predictive, proactive and progressive, which is in line with the ethos of a *Future Ready Force* (**FRF**) as concepts of Inclusion, Agility, Resilience,

and Foresight are required to build agile combat teams. Future proofing & restructuring the Armed Forces and communicating the organisation's long-term purpose are important aspects for building a radically adaptable FRF. The pandemic showed that slow change can leave an organisation behind, thus radical adaptability may well be the survival practice of a modern day **FRF**. High performing teams go beyond cooperation; they need to operate in backdrop of a converged C4ISR backbone. Concept of co-elevating teamwork, wherein team members together create results that raise their capabilities as individuals, is a central aspect for Joint C4ISR & FRF; where synergised power of Integrated Tri Service team scan be leveraged.

Role of Technology & C4ISR in Future Conflicts

We are in the midst of a major technological transition and any conflict in future will see preponderance in use of technology to enhance C4ISR capabilities of the force. A *Future Ready Force* (**FRF**) needs to incorporate all emerging concepts of warfare which are technology predominant, essentially all-encompassing and impact the geostrategic, geo-economic and geopolitical domains. Though the pre-eminence of infantry and AFVs needs no justification on account of the need to have boots on ground, yet essential components which need to be factored are cyber, space, special operations, informational warfare, psychological operations, legal, electronic, electromagnetic, hybrid / asymmetric ops, drones, Unmanned Combat Aerial Vehicles (**UCAVs**) & autonomous weapons/ vehicles including drones. These elements would in some measure also need to be integrated with the infantry and AFVs, which may be required to operate in small cohesive teams, forming part of cohesive Integrated Battle Groups (**IBGs**), which is where Joint C4ISR will have a major role to play.

A **FRF** has now become imperative due to the tremendous spurt in technological growth, which includes both *Incremental &Disruptive*

Technologies. Emerging technologies in general denote significant technological developments that broach new territory in some significant way in their field. Examples of currently emerging technologies include IT, nanotechnology, biotechnology, cognitive science, robotics, and Artificial Intelligence (AI).[1] The present day war between Russia and Ukraine has cast an ominous shadow of doubt on the survivability of AFVs against the onslaught of Drones. This is another example of the innovative manner in which Drones have been used to not only enhance C4ISR but to also act as a potent kinetic kill platform.

A **FRF** is envisioned as a complex yet coherent force that will expand the operational scope and reach of a nation's strategic-military establishment. Such a force should ideally employ the concept of Multi Domain Warfare (**MDW**) through Joint C4ISR. Though there are many technologies which will drive these changes and which will play a major role in all future conflicts, yet from amongst these technologies, only few prominent ones which have a major role to play in shaping the **FRF** will be discussed. Space, Cyber, Communication, Nano Technology, Artificial Intelligence (AI), Robotics, Drones & UCAVs and the effect of these technologies, in shaping the **FRF** in the Indian sub-continent will be discussed.

Space. Space capability is being exploited mainly in the fields of communication, Positioning, Navigation, Timing (**PNT**), surveillance, various other space applications which have tremendous potential in enhancing C4ISR capabilities. Development of space exploitation capabilities and selective development of counter Space capability will be instrumental in enhancing national security. Being a scarce resource, C4ISR capabilities available in this segment will need to be shared by the three services, under the ageis of DCA, HQ IDS, thus reinforcing the importance of Joint C4ISR for a **FRF**.

Cyberspace. Cyberspace today is a complex environment involving underlying ICT infrastructure used by common citizens, social media,

businesses, government including military across the world, thus blurring boundaries in time and space. Cyberspace has acquired strategic position by virtue of its global reach and it's rapid integration into the social, political & economic discourse and framework. Malfunctioning or breakdown of a well-knit web may have serious implications on social well-being, economic and business interests of a Nation. Therefore optimal exploitation of Cyberspace is a prerequisite for a **FRF**.

Martin Ford, author of 'The Lights in the Tunnel: Automation, Accelerating Technology and the Economy of the Future',[2] ,states that as IT advances, machines[3] and software will exceed capability of workers to perform most routine jobs. As robotics & AI develop further, even many skilled jobs may be threatened. This is applicable & aptly true even in the context of a **FRF**, though the political compulsions of finding adequate job opportunities may slow down the process of replacing humans with robots.

Acronyms of Few Emerging Technologies Enhancing C4ISR

Most of these emerging technologies referred to for boosting Joint C4ISR capabilities for a **FRF** are not employed in isolation but in concert with two or three other such emerging technologies; thus a number of acronyms have come up and few of them are as listed below:-

- **NBIC**, an acronym for Nanotechnology, Biotechnology, IT and Cognitive science, is a term for emerging &converging technologies. It was introduced into public discourse through the publication of *Converging Technologies for Improving Human Performance*, a report sponsored in part by U.S. National Science Foundation.[4]

- **GNR** (Genetics, Nanotechnology & Robotics) also propounds the same concept & found mention in Bill Joy's article in 2000 on '*Why The Future Doesn't Need Us.*[5]

- "**GRIN**", for Genetic, Robotic, Information & Nano processes/ Nano-technology,[6] was first used by Journalist Joel Garreau in *Radical Evolution: The Promise & Peril of Enhancing Our Minds, Our Bodies& What It Means to Be Human.*

- "**GRAIN**", for Genetics, Robotics, AI and Nanotechnology[7] is used by Science journalist Douglas Mulhall in his book titled *Our Molecular Future: How Nanotechnology, Robotics, Genetics & AI Will Transform Our World uses* "

Convergence amongst these technologies is evident and is a critical element underwriting the Multi Domain Warfare (**MDW**) concept. However MDW will be feasible only in the backdrop of a converged C4ISR architecture, hence the same is imperative for a **FRF** which would be required to carry out MDW. This requires convergence between inter-organisational and military capabilities, across multiple domains and environments, both in time and space. These create windows of advantage that enable an FRF to maneuver from a position of advantage. In this article, an attempt has been made to list out certain niche technologies which empower any **FRF** to undertake MDW, in the backdrop of a converged / Joint C4ISR architecture.

The aspects of Space exploitation / threats, counter Space capabilities and of Cyber are very much a part of any FRF but being a domain in itself, as such these are not being deliberated upon further in this article.

This paper will primarily discuss the role played by three enabling technological domains ie *Nano Tech, AI& Robotics (to include Drones and UCAVs)*, in enabling and empowering C4ISR capabilities that a *FRF* would need. The role played by these enabling technological domains, in shaping Information Wars in the Indian Sub Continent in the age of MDW, supported by an enhanced Joint C4ISR will also be analyzed in subsequent paragraphs.

Nano Technology

Nano Technology is a science dealing with manipulating matter at molecular scale. Nano sized particles exhibit different properties, other than those exhibited by their bulk (matter) counterparts. In case of Nano particles the concepts of Quantum mechanics, interplay of Electro Magnetic forces & effects due to random molecular motion become more pronounced and relevant. Due to the inherent advantage derived from small size, Nanotechnology finds enormous scope in military applications ranging from Nano Fiber for camouflage & stealth, Body Armour, Nano Robotics, Nano drones, Armed Robots etc. Few such applications have been explained in subsequent paragraphs.

Nano Fibers for Structures and Body Suits.

- **Associated Technology**. The small size and inherent strength on account of Quantum mechanics, interplay of Electro Magnetic forces and other factors make Nano Fibers suitable for improved weaponry and body suits with enhanced strength. This facilitates preparation of intelligent fabric with Computer & ICT inter weaved into the fabric, which is especially useful for making 'Body Armour'. This type of body armour is light weight and can be made more intelligent by incorporation of Health Monitoring system with tagging and tracking facility, providing enhanced C4ISR and battle field transparency.

- **Role in Shaping Wars**. Our borders with our neighbors in the West and the North/ North East are such that there are large No of remote in-accessible areas where advance medical support is not easily available. This type of body suit permits remote diagnostics and management of health parameters & is a major technological breakthrough, as it

will reduce the logistical dependency on casualty evacuation. This will indirectly strengthen the tenability of our defenses in the Siachin Glacier. Whichever nation state is more technologically advanced will stand a better chance in exploiting the same.
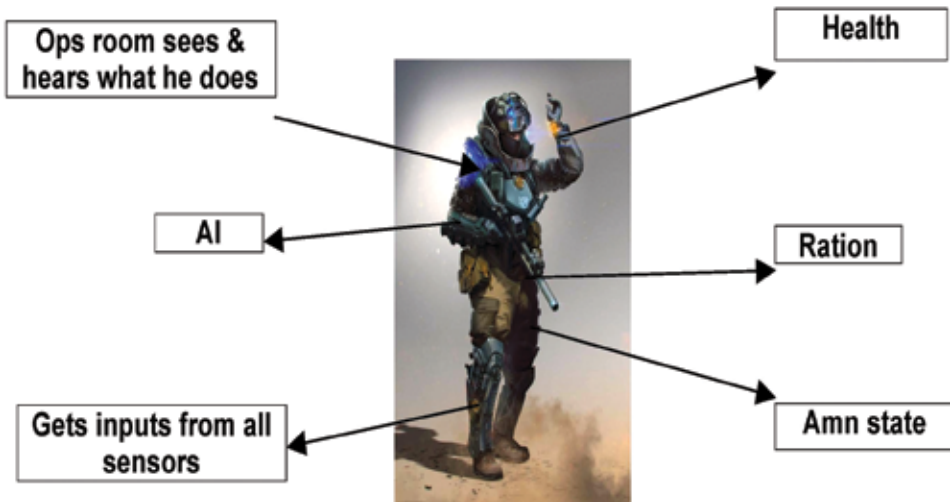

Fig 1:The Futuristic Soldier

The futuristic soldier shown in Fig 1 above will wear at least six sensors/ IP addresses; one each for monitoring the ration state, ammo state, health, for AI, to get inputs from all sensors and one to relay to the ops room, so that that the commander sitting there sees & hears what all he does. In one stroke the Joint C4ISR capabilities of Commanders are enhanced in the tactical domain, providing real time control of the operational situation and also empowering him in timely provisioning of requisite logistical support including medical assistance. Once an enhanced level of networking convergence is achieved, the input/ updates to the Commanders can even be automated.

Nano Robotics & It's Role in Enhancing C4ISR.

- **Associated Technology**. Due to the inherently small size, the Armed Robots can be made miniaturized, thus providing a smaller cross sectional area to be targeted, which in turn enhances their survivability and reliability, accuracy, lethality & efficiency on the battlefield. Such Nano Robots can also be employed in clusters and can be remote controlled, greatly enhancing the canvas of C4ISR.

- **Role in Shaping Wars**. This not only prevents loss of valuable human life in battlefield, but acts as a double edged weapon, especially in the context of porous borders. India has managed to fence it's large borders and put in place surveillance devices to monitor infiltration. However with the option of Nano Robots now available to the adversary also, preventing infiltration by Nano Robots, will be challenging and puts an additional strain on the surveillance grid. The side which is more technologically competent will be able to optimally employ these Nano Robots in the battlefield as they will be able to provide enhanced accuracy, lethality, efficiency, reliability & battle field transparency, leading to better Joint C4ISR.

Unmanned Air Surveillance.

- **Associated Technology**. UCAVs are being put to effective use by a No of developed nations to carry out precision strikes, with virtually no loss of life and nearly 99% assured success / strike rate and surveillance using **UAVs** is already creating waves. So acute is the problem that nations have developed and designed weapons to specifically target UCAVs and UAVs. However using Nano Technology now Nano Drones

having Nano processors can be made. These light weight and power efficient devices will provide their adversaries with a smaller cross sectional area to be targeted, which in turn makes them difficult to be detected and enhances their survivability and reliability.

- **Role in Shaping Wars**. UAVs and UCAVs are actually a game changer and they can partially bridge the divide between affluent nations which can afford latest 5th generation combat fighter aircraft/ MBTs and those which are unable to do so. Nano Drones can form a Smart/ Surveillance Dust, in which large number of Nano drones can form a decentralized net with computational and wireless communication capabilities. Thus due to the large numbers in the swarm, the disadvantage of limited computational power available in a single Nano Drone can also be overcome by the Smart / Surveillance Dust, comprising of a swarm of such miniature drones.

- The efficacy of drones has been demonstrated during the Army Day 2019 and has been seen in the recently concluded conflict between Armenia and Azerbaijan as well as in the ongoing war between Russia and Ukraine. These Drones can be used as air borne weapon platforms, as well as for surveillance, enhancing Joint C4ISR to the next level; in turn facilitating synergistic application of force within the three Armed Forces. This provides an asymmetric advantage to the side possessing drones and is an essential weapon platform in the arsenal of any *FRF*.

Adaptive Camouflage & Stealth Coatings.

- **Associated Technology**. It's been correctly said that "you

can't shoot what you can't see." Using nanotechnology, the Electro – Chromatic properties of materials/ protective coatings can be altered dynamically to adapt to surroundings. <u>Cloak Of Invisibility</u>[8],[9] is made possible due to <u>camouflage</u>/ cloaking microscope tips at optical frequencies.

- **Role in Shaping Wars**. Nanotechnology enables ever increasing battle field transparency, making soldiers and weapon platforms invisible / difficult to detect. Thus the shooter or target platform is there but is not visible to the adversary, which enhances both it's lethality and survivability. This will be of immense use when the infantry would be required to operate in small cohesive teams forming part of cohesive Integrated Battle Groups (IBGs). It's applicability and utility for the Special Forces (SF) of the three Armed Forces (ie Para SF, MARCOS & GARUD Commandos) needs no elaboration and will in a way promote joint-manship.

Nano Sensors.

- **Associated Technology**. These are extremely small in size with high sensitivity and large surface area. They are capable of chip sensing, intelligent power savings & wireless communications, all of which makes them extremely useful for military usage and in enhancing the existing C4ISR envelope.

- **Role in Shaping Wars**. These are low cost & disposable, thus suitable for mass production and for deployment in remote, inaccessible areas, where retrieval, repair and recovery is either difficult or not economically/ tactically viable. Such terrain is found in plenty in the Indian Sub-continent. This attribute lends them suitable for various

Military Applications, few of which are as listed below:-

- Bio Chemical sensors for detecting NBC activity.

- Integration with Body Suite for Health Monitoring.

- Battle field surveillance.

- Forming Wireless Nano Sensor Networks comprising of large number of Nano Sensors operating in cohesion to cover large area's.

- Intrusion detection along critical gaps and at vital installations.

Nano Biotechnology.

- **Associated Technology**. Nano Biotechnology incorporates diagnosis and administration of drugs and is especially relevant for wounded soldiers using Nano Sensors. Nano Sensors embedded body suits permits remote diagnostics and management of health parameters & are generally used in remote inaccessible areas where advance medical support is not easily available.

- **Role in Shaping Wars**. Remote monitoring of soldiers health to maintain peak levels during operations is important and is possible due to Nano Biotechnology aided by Nano Sensors. This is especially useful in case of troops deployed in remote, inaccessible areas, where on call medical evacuation is either difficult or not feasible/ tactically viable. Adoption of this technology could give a fillip to the operations being conducted in the North and North East and serves as a uniform parameter/ platform to render medical support to the personnel of the three Armed Forces.

Artificial Intelligence (AI)

AI is intelligence demonstrated by machines in contrast to natural intelligence displayed by humans & other animals. In AI a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" & "problem solving. Certain prominent traits / capabilities that researchers expect an intelligent system to display are:-

- Reasoning, problem solving
- Knowledge representation
- Planning
- Learning
- Natural language processing
- Perception
- Motion and manipulation
- Social intelligence
- General intelligence

Associated Technology and Tools of AI. Many AI problems can be solved by intelligently searching through possible solutions, however AI automates this process through iterative learning. The logical proof can be viewed as searching for a path that leads from premises to conclusions, where each step is the application of an inference rule. Logic is used for knowledge representation and problem solving. The decision tree is perhaps the most widely used machine learning algorithm. Neural networks, or neural nets, were inspired by the architecture of neurons in the human brain and have simply automated an existing time tested physiological function.

Applications of AI. High-profile examples of AI include autonomous vehicles, medical diagnosis, creating art, proving mathematical theorems, playing games, search engines, online assistants (such

as Siri), image recognition in photographs, spam filtering, prediction of judicial decisions and targeting online advertisements. With social media sites overtaking TV as a source for news and news organisations increasingly reliant on social media platforms for generating distribution, major publishers now use AI technology to post stories more effectively and generate higher volumes of traffic. This provides ample scope for effective utilisation for IW, strategic communication, perception management and to also shape perceptions.

Role in Shaping Wars.   Autonomous vehicles ie drones and self-driving cars can be effectively used for surveillance and bomb disposal tasks. AI can facilitate remote medical diagnosis at inaccessible high altitude locations and can help in solving mathematical problems which are a key in cracking cryptographic codes. Wargames, search engines especially programmed for military use, image recognition in photographs, prediction of strategic/tactical decisions by the adversary are some other areas where AI can play a major role. The predictive decision making dramatically shortens the OODA loop, enhancing C4ISR. AI can also be used to shape the environment by generating content and posting stories more effectively over various social media platforms, in order to generate favourable opinion for the Armed Forces and for the nation. AI being ubiquitous to the colour of the uniform, is a great enabler of Tri Service synergy, thus enhancing Joint C4ISR.

Winds of Change.   Roles in IT companies that were typically assigned to employees with over 10 years of experience—the mid-level bracket—are now going to machines. For example, Capgemini is using IBM's cognitive consulting tool *Watson*, to assign people to projects, while Infosys is building a machine-learning platform that will help project managers take decisions to make better trade-offs between the number of people needed for a project and the timeline for completion. Such a transition can be expected to take place in the Armed Forces also where the background data / facts and figures would be prepared and

presented by AI enabled machines and put up to the commander for his decision. The training imparted to various staff officers would need to be restructured accordingly. Possibly certain mundane aspects of the execution could also devolve down to such machines. In the Indian Sub-Continent all major nations are going into digitisation in a big way and it is but natural that the transformation in the military will also take place accordingly on these lines. This change will be implemented uniformly across the three services and having a Joint C4ISR will go a long way in ushering in this change.

Robotics

Associated Technology. Robotics is an interdisciplinary branch of engineering and science that deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. These technologies are used to develop machines that can substitute for humans and replicate human actions. Many of today's robots are inspired by nature, contributing to the field of bio-inspired robotics.

Role in Shaping Wars. Robots are ideally suited for military applications and are being used in dangerous environments (including but not limited to bomb detection & deactivation), manufacturing processes and environments where humans cannot survive. Robots are suited for operating in an NBC/ NBC prone environment, where precision measurement / action is required and where it is not advisable for humans cannot to operate. The Indian Sub-Continent and it's immediate neighborhood comprises of possibly the largest concentration of both nuclear weapon capable nation states and those that are a victim of terrorist activities; this region thus has ample scope of employing this technology, in the backdrop of Joint C4ISR.

- **Robotic Surgery**[10] [11] [12] can relive surgeons to perform other

life saving tasks / supervise robotic surgery. This is a boon for military applications as there is always a requirement of (and a shortage of) skilled medical specialists in the forward areas.

- **Exo - Skeletons** are an extension of robotics with mil applications and may eventually reduce the need for Armoured Fighting Vehicles (**AFVs**), as each soldier will be an intelligent Armoured Fighting platform. This is a boon for militaries constrained by shrinking defence budgets. Since time immemorial, armies created obstacles to separate the mounted cavalry from the foot infantry & subsequently to separate the AFVs from the infantry, giving rise to the Ditch cum Bundh (**DCB**) canal defence system. The Exoskeletons, powered by Joint C4ISR, can help achieve the synergy of infantry and armour, which has been the challenge all armies have grappled with.

- **Powered Exoskeleton**[13] will make feasible Future Force Warrior (like Iron-man). This will provide a solution for heavy lifting and for paralysis / muscle related diseases and possibly a Human Universal Load Carrier. **Swarm Robotics**[14] will also be possible due to swarm intelligence, autonomous robotics, nanorobotics, particle swarm optimization, multi-agent systems and behaviour based robotics. All this will need to backed up with a robust Tri Service communication network, eventually resulting in enhanced Joint C4ISR.

Artificial Intelligence (AI) & Robotics

Convergence of both AI & Robotics will result in creation of AI robots. If the utility factor of both AI & Robotics is (say 'x'), then the utility factor of an AI Robot will not be twice 'x'; rather it would be 'x' square. Likewise if

Nano-technology was to be combined with AI & Robotics then we would end up with AI Nanobot, with an extremely high utility factor. The military applications and employability of such an empowered weapon platform are endless and are limited only by imagination. Smart manufacturing represents a leap forward from traditional automation to fully connected and flexible systems. The industry needs to embrace the challenges and opportunities of this new era and the FRF should readily adopt it.

Pitfalls of AI and Robotics

The world leaders are seized of how robotics, AI, and IoT are being adopted and how they will transform the world. It however needs to be correctly understood what would be the impact on history of self-learning machines[15] ie machines that acquired knowledge by processes particular to themselves and applied that knowledge to ends for which there may be no category of human understanding. Would these machines learn to communicate with one another? How would choices be made among emerging options? Mankind is at the edge of a new phase of human history where the situation to embrace technologies of MDW seems to be incomprehensible and even awe-inspiring to us. However any FRF would need to take the leap of faith and embrace these technologies, eventually enhancing Joint C4ISR.

Responsive 5G Backbone Communications

In order to make all the above attributes a reality, there is a need to have in place a responsive backbone communications grid with adequate bandwidth, low latency, a very high state of reliability and enhanced computing power at the edges. All this can be provided by a Military IoT(or MIOT) powered by 5G backbone communication grid, facilitating Joint C4ISR. The Armed Forces already have a strategic Tri Services Communication network and Project Network for Spectrum (NFS) is in the process of being rolled out. These will greatly enhance the Joint

C4ISR capabilities of Defence, ushering in synergy within the three Armed Forces, by way of a common applications riding over a converged network.

Conclusion

When considered in its abstract form, the FRF will wage wars using the MDW concept which is intended to be an all arms and all capabilities affair. The changing character of warfare will entail embracing this concept, which appears to be designed to degrade the deterrent potential of an anti-access system, and to render ineffective its kill-chain. The traditional approach followed by armies the world over is to neutralise a defender's anti-access system with overwhelming force. AFRF adopting the MDW will seek to selectively target, in a bid to degrade and/ or destroy - key capabilities of anti-access system. All the technologies listed above in this paper enable this desired end state. By leveraging these technologies, the FRF will not only drastically shorten the OODA loop but will also usher in synergetic application of Joint C4ISR, which will prove to be the battle winning factor in all future wars.

To quote Vice Admiral (Retd) Arthur K. Cebrowski of the U.S. Navy, and John J. Garstka,[16] at the turn of a millennium we are driven to a new era in warfare. Today there are 4 Billion Internet users, 3.8 Billion active mobile internet users and 8 Billion IOT Devices in the world. India's national stakes are huge in global cyber space, thus implying it's stakes in AI, Nano technology, Robotics and their consequent affect in MDW in shaping the Information Wars in the Indian Sub-Continent. There is thus a pressing need for a suitably equipped technology savvy Joint C4ISR enabled FRF to be in place.

There are no binding laws on cyber space governance and the other dimensions ie AI, Nano- Technology and Robotics are as yet "Global Commons" and uncharted territory. We are going through a fundamental

shift from platform-centric warfare to Network-Centric Warfare (**NCW**), which is as resilient as the concept of unrestricted warfare, which a FRF will need to imbibe.

C4ISR exploitation & MDW are the next important development in waging war and a FRF should be geared up to embrace the same. Multi-Domain Battle requires converging inter organisational and military, as well as lethal and nonlethal capabilities, across multiple domains and environments in time and space. This creates windows of opportunity that enable the FRF to gain a position of advantage. A beginning in this direction has been made by ushering in the concept of Integrated Theatre Commands (ITCs) & IBGs. These structures need to be fleshed out with a FRF which is effectively able to leverage the latest technology to optimally exploit C4ISR.

The domains of MDW include, but are not limited to, the geophysical and electromagnetic categories, leading to unrestricted warfare, which any FRF will be required to grapple with. A FRF employing MDW is the future and is thus likely to have a major effect in shaping the Information Wars in the Indian Sub-Continent. The importance of making the correct strategic choices to adapt or even survive in such changing ecosystems[17] is thus important and it is imperative to usher in a FRF which will effectively leverage various technological attributes to enhance C4ISR.

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