# Evolution of Indian Control and Reporting System for Future Aerospace Warfare

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"In order to assure an adequate national defense it is necessary and sufficient to be in position in case of war to conquer the command of the air."

—General Giulio Douhet

**PROLOGUE**

**Control and Reporting.** Control and Reporting or C&R can be defined as Controlling of Fighter aircraft and other weapons associated with Air Defence of the Country based on the information available through medium of Radars and other Intelligence and Surveillance sources. This set-up of utilising available information into actions by means of executive directions to ensure Air defence of Nations can be very broadly classified as C&R.

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The year is 1912; on a cold evening in Europe, a Turkish soldier shoots down an Italian aircraft in Italy-Turkish war.[1] Though this shooting of aircraft was an intrinsic human behaviour to shoot down one's enemy, that soldier scarcely knew that his actions would be part of a history about a concept that would revolutionise military affairs all over the world. ***"And that concept was Air Defence"***. Soon, the importance of denying the usage of aerial dimension to the enemy was realised and the battle to dominate the medium of Air started. It was hardly a matter of time, when militaries everywhere would start contesting for dominating the Space dimension and thus warfare would extend from Air to Space.

There are certain pivotal points in history when actions taken by individuals or organisations alter the future course of warfare. As the agency responsible for the Air Defence of our nation, the Indian Air Force (IAF) today stands at one of those crucial points. The path we choose from here on shall determine our ability to adapt to the changed paradigms ushered in by Net Centric Operations in future in the **Aero-Space domain**.

The IAF is in a state of transition for quite some time now and is constantly evolving professionally on all fronts. In any C&R system, induction and networking of a multitude of state-of-the-art systems is an absolute necessity so as to provide a much higher degree of transparency of the battlefield. This in turn would improve the Situational Awareness of any Air Force manifold. The induction of Automated Indian C&R system, also known as Integrated Air Command and Control system (IACCS) in the IAF, also marked an important landmark in technology wherein system assisted decision making became a key aid in minimising the element of human error substantially.[2]

1. https://www.turkeyswar.com/prelude/turcoitalianwar/
2. https://www.indrastra.com/2015/09/ANALYSIS-IACCS-257.html

In the present context, as we have witnessed in the Russia-Ukraine war, defence of national territory is a major and complicated task. The advancement of science and technology has proved that the future warfare is going to be based on integration of various weapon systems. Historically, when the army fought in a given area of battle, the controlling agency behind the fighting flanks had orchestrated the units to effectively progress in the battlefield. The concept has remained the same and will remain the same with the advancement of technology. **In aerial warfare, Control and Reporting (C&R) centres today with different nomenclatures around the world are the nerve centres to carry out Air Defence operations**. This article aims to understand the C&R system, examine the scope for improvement and analyse future prospects for the evolution of the Indian C&R system.

## CONCEPTION

The responsibility of the Indian airspace lies with the Air Force.[3] IAF, since its inception, has been working in both the roles, that is, offensive as well as air defence. Air Defence planning is done by analysing the **area to be defended vis-à-vis the resources available**. There are three essential concepts of Air Defence. **Point Defence, Limited Area Defence and Area Defence**. These are employed individually or in combination. The resources mainly consist of aircraft, radars, Surface-to-Air Missiles and Air Defence guns.

**Active AD Sub System.** The functions of an active air defence sub-system are:

- Detection
- Identification
- Interception
- Destruction.

3. https://www.idsa.in/issuebrief/air-defence-command-kkhera-270120

**Contemporary Air Defence Set-up in IAF. All of the functions are executed by different organisations in IAF as per their Role**. There are some important ingredients of an Air Defence System, which work in unison for an effective overall control and reporting. These are as follows:

- **Effective Communication.** To coordinate the various components of an AD system, good communication systems are vital. The importance of reliable and speedy communication can never be over-emphasised. The most efficient AD system can be rendered useless if the various components are not connected by a good, secure, foolproof and dedicated system of communication.
- **Electronic Counter Measures/Electronic Counter-Counter-Measures.** Today's war is highly technology driven and increasingly reliant on electronics. Therefore, it is obligatory to have an organisation, which aims at detecting, disrupting and deceiving radar and radio communications of the enemy, as well as countering such degradation of our equipment by the enemy.
- **Information Gathering.** To provide reliable information about enemy equipment, capabilities, tactics and plans, prior to and during hostilities, a good intelligence network is a prerequisite for any C&R or C2 (Command and Control) organisation around the world.
- **Unified Command.** The key to success in any form of employment of air power, be it air defence, offensive support or offensive operations, is *flexibility* and the key to flexibility is unity of command. This characteristic is fundamental to air defence operations in particular. Without unity of command, it can never be possible to obtain the fast responses which are essential for an effective air defence set-up. ***This is very critical for effective functioning of any C&R organisation at Tactical as well as Strategic Level***.

- **Criticality of TBA and Integration.** With proliferation of quick reaction Army Air Defence assets and SAMs, **integration of family of weapons particularly over Tactical Battle Area (TBA)** becomes crucial to avoid fratricide. In such a context unity of command implies centralised control under one agency during operations, while command of individual weapons systems continues to remain with different services/ formations/units.[4]

**FUTURE PERSPECTIVES**

**The principles of Air Defence are Mass, Mix, Mobility and Integration**. The control and reporting (C&R) structures must be able to effectively handle a number of AD units including radar system, fighters, SAM and communication system including Ground-to-Air, Ground-to-ground and Air-to-Air, i.e., "**mass**", and a "**mix**" of airborne and ground-based weapon systems. The C&R systems should be at the same time responsive to the changing tactical situation, which involves "**mobility**" and "**flexibility**". Finally, all the elements, irrespective of Air Force, Army or Navy, need to be **integrated** to provide a layered and in-depth coverage. Subsequent paras will dwell upon the glitches faced by any C&R system around the world.

- **Surveillance Capability.** Threat can approach the targets not only at high/medium levels but also at treetop heights. History has witnessed that all the skirmishes of IAF with its adversaries have originated from the hills of the Himalayas. Therefore, an efficient all level Radar coverage in all terrains is the backbone and necessity for any C&R system in today's environment.
- **Security of Communication.** Communicating with each other during combat with extreme secrecy holds the topmost importance for any commander orchestrating their troops in

4. http://www.indiandefencereview.com/news/intense-tactical-battle-area/

the battlefield. The earlier era Runners used for communicating among troops were substituted by modern Line-of-Sight radio communication systems and space-based communication systems throughout the world. But these communication systems are vulnerable to enemy information attacks. Hence, C&R structure's biggest challenge is always maintaining the secrecy and security of communication used by them. Towards this, India has also pushed ahead with indigenous development of Software Defined Radios capable of multiple types of waveforms including wideband and narrowband applications.[5]

- **Mobility.** Many AD systems and C&R assets suffer from lack of mobility. Mobility in any warfare is still, and will always remain, the best form of defensive tactics against any threat. Mobility also augments gap-free airspace surveillance. Monitoring of airspace by Mobile radars and thereafter its quick redeployment will deceive the enemy in terms of intelligence.
- **Integration of Assets.** All the sensors of IAF are integrated providing network-centric warfare capability.[6] Additionally, integration of the various other elements of AD like SAM system, including Long-Range or Medium-Range SAMs as well as ISR and IEW system in the same network, is an absolute necessity in today's environment so as to provide a holistic picture for effective decision making at centralised C & R system.
- **Centralised Command and Control.** For air defence of Indian Airspace, AD assets include all the assets of IAF, Indian Army and Indian Navy. For the effective employment and control

5. https://www.financialexpress.com/defence/aatmanirbhar-bharat-software-defined-radios-for-the-armed-forces-to-be-made-in-india/2607327/
6. https://www.vifindia.org/article/2020/august/24/india-s-air-defence-what-needs-to-be-integrated%20

of AD assets, Unification of C&R is a necessity so as to enable control by a single agency at strategic level.

**FUTURE EVOLUTION OF SYSTEM**

Technological advancements to improve the operation capability of integrated air defence are manifold. As we see, there are different domains which are responsible for a particular function of AD. Hence, the structured development only will ensure the best possible combination. Some of these are as follows:

- **Future Generation Air Defence systems.** Integrated Air Defence Systems is a key feature of modern warfare. The "air defence systems", also called **"air and missile defence" (AMD)** systems, provide surveillance, tracking, command and control, and weapons delivery capabilities to battlefield commanders. This includes networking multiple types of ground-based radars (e.g., long-range surveillance radar, engagement radar), air and space-based capabilities to provide a larger and more comprehensive picture of the battle space. Thus, this communication network needs to be a huge network of hundreds of ISR sensors of space-based ISR platform, ground-based radars and weapon platform feed into broader information network. Towards this, a networked C4ISR system needs to be developed capable of locating and tracking targets and fusing intelligence into a coherent battlefield picture. The networked technologically advanced C4ISR system is essentially to provide reliable, secure communication to fixed and mobile command post, thus enabling rapid, effective, multi-echelon decision making.
- **Secure communication network.** In military, communication is the backbone of operations. Hence, different modes of communication have to be secure in order to safeguard the data as well as voice. The same can be done by providing communication equipment which has coding and decoding

facility. The only hindrance would be to link up various communication sets being used in different platforms to work in unison. Once the encryption is done, all the data and voice sharing will be secure.

- **Cyber threat.** In Network Centric Warfare (NCW), information superiority is translated into combat power. With advancement towards integrated network-based Air Defence structure, threat of cyber intrusion by enemy has also increased manifold. In the present system various vulnerabilities exist due to cyber ops by enemy at various echelons of the network-centric system. Hence, the countermeasures would involve monitoring of C&R system by security operations centres for any unauthorised access/insertion of unauthorised media. ***Development of the hardware needs to be addressed using own systems without reliability on other nations***.
- **Integration Philosophy of mobile AD elements.** All mobile units/vehicles should be fitted with IRNSS (Indian Regional Navigation Satellite System) based positioning system which will enable real-time monitoring of all the AD assets while on the move and also when deployed. This will not only help in tracking of all the assets but will also help in faster integration and sharing of location data. It will also act as a boon while SAGW systems are moved from one place to another. It will give real-time position of all deployed SAM systems, hence doing away with the present system of manually taking location of such potent systems. This system can also be utilised onboard aircraft, which will provide GPS-based real-time position of aircraft flying in air as it is currently available in ADS-B based systems wherein GPS systems update position of aircraft in real time.
- **Integration of all AD assets either through organisation or ConOps.** There is a need to identify the commonalities and overlaps, and integrate assets of the three services. The

focus needs to be on enhancing operational effectiveness and efficiency, capitalising on the core competency of each service. The core competencies of all the services should be exploited. While doing so, it would be critical to examine the nature of future wars and the types of threats which will emerge. Based on this critical and holistic examination, on both of the borders, as also of the hinterland, the new organisations will have to be formulated not just in coordination between the three services but also with civil bodies like DGCA, AAI, and Centre/State Governments.

- **Automated Air Operations using Artificial Intelligence.** Artificial Intelligence in integrated C&R will be a boon since there are multiple mental calculations required while carrying out tactical control as well as making correct decisions. Therefore, inclusion of AI in upcoming software upgrades will improve decision making. With modern inductions and integrated air operation, it is important to reduce the analysis and reaction time by effective man and machine interface to have automated air operations and timely generating desired solution. Artificial Intelligence will be such a step towards minimising the workload on users by assisting and providing automated alerts/solutions based on desired algorithm given by the user.
- **Utilisation of Drones.** Drone-based airborne sensors are to be utilised for gathering required data in terms of EW aspects, optical data and ELINT. The system will function as airborne radar, with fluidity in operations. Real-time assessment of the ground picture, analysis of the same and allocation of the target in real time by airborne/ground weapon system is the way forward. This can be possible by effective integration of the real-time SIGINT/IMINT of the system.
- **Tactical exchange of data in real time.** Tactical exchange of data not only between AD agencies, but also between all peers

of C41SR is an absolute necessity for future aerospace warfare to enable real-time dynamic targeting and further reduction in sensor to shooter time.

- **Integration of Ballistic Missile Defence (BMD) systems.** The extensive use of Tactical ballistic missiles and Cruise Missiles in ongoing Russo-Ukraine Conflict has highlighted the vulnerability of Static and Semi-Static C&R centres in Ukraine.[7] The same is a lesson for defence forces the world over. While these missile systems pack a heavy strike punch, they also affect the morale of personnel. Therefore, decision makers in future will be using the BMD systems to defend against these threats, which entail Integration of BMD systems into C&R system in future for quick decision making in future aerospace warfare.
- **Mobile C&R stations.** Many C&R stations around the world are located at static locations and are vulnerable to attack by enemy through standoff weapons, cruise missiles, SSMs and even conventional weapons. Therefore, a concept of **Mobile C&R stations** with SATCOM as communication media can be developed with graded down resources by keeping the requirement of future in mind, which can further act as a sub-C&R station centre or may be merged with static C&R station concept.
- **Future Evolution into Space Domain.** Efforts should be made to have a complete fallback of C&R systems on Space-based capabilities with complete redundancy. This usage of space medium should not only be as a communication backbone, but should also aid in integration of information likely to be received from space assets in future.

7. https://www.armyrecognition.com/ukraine_-_russia_conflict_war_2022/discover_russian_iskander-m_tactical_missiles_used_to_target_ukrainian_army.html

## CONCLUSION

Integrated C&R systems with ISR, offensive and Space assets have tremendous potential to change the course of any battle. Future evolution will be to migrate the C&R system completely relying on Space-based assets and real-time transfer of all the data required for Offensive and Defensive Operations.