

ADVANCEMENTS IN COMMUNICATION TECHNOLOGY AND THEIR RELEVANCE AND C2 IMPACT ON DOCTRINE AND CONCEPT

INTRODUCTION

"A downsized force and a shrinking defense budget result in an increased reliance on technology, which must provide the force multiplier required to ensure a viable military deterrent....Battlefield information system became the ally of the warriors. They did much more than provide a service. Personal computers were force multipliers."

- Gen Colin Powell ¹

1. The battle cry of the communication revolution is "better, faster, cheaper." The only field where cost is continuously falling down with improved performance is Information Technology field. The fusion between computers and communication is complete. A \$2000 laptop is more powerful than a computer worth 10 million dollar 20 years back. A 3 minute New York- London phone calls in 1930 would have cost \$ 300 in today's price, today it costs less than \$10 and quality of speech is much better.
2. The revolution in information technology is also causing revolutionary changes in how warfare will be fought in today's information age. All over the world there is a dramatic reduction in cost and increase in facilities in all information technology fields. Cost of making a telephone call, sending a mail or data have come down drastically whereas the computing power of computer is increasing dramatically with rapid reduction of cost and size. The software interaction is becoming more versatile and more user friendly and fantastic facilities are available in these softwares. All the latest technology such as the Global Positioning System (GPS), satellite surveillance, fibre optic communication, Direct Broadcast systems (DBS), internet access, cryptography, sensors and precision weapons are commercially available in world market. Technology is improving the methods of obtaining and disseminating information.
3. The performance i.e. accuracy, reliability, lethality – of individual weapons has been enhanced by microelectronics networking. The information technology content of the average military system has been growing steadily. Data communications can now unite sensors, platform, weapons and command into far more potent capabilities than those of high performance system operating autonomously. A new military formation – the network permits forces to be dispersed and integrated, making them more maneuverable, deadly and invulnerable.

4. The ability to integrate weapon, sensors, platform and other military systems such as network depends on rugged command, control, communication computing, intelligence, surveillance and reconnaissance (C⁴I SR).

5. Information Technology is eliminating the inverse relationship between weapon range and accuracy, and thus lethality combined with the improved ability to find and follow enemy units, such lethality permits rapid and systematic destruction of enemy targets.

6. Small, light ground units able to call upon large arsenals of affordable precision – strike munitions on remote platform can pack a heavy offensive punch. This will make them more than a match for much larger enemy forces and permit quicker deployment and reduced logistic demands.

7. The networking of forces does not eliminate the need for ground forces in all instances. However, it can revolutionize the way they too are organised and employed. With information technology, they can disperse and “Swarm” executing fast maneuvers and lethal attacks without massing. An enemy force without such C⁴ISR, deployed in large formations, will find it difficult both to attack such networked ground forces and to survive their attacks.

8. Though technology can be seen as a force multiplier, the limitations of information and technology as tools of war need to be recognised and their risk assessed. The success of the coalition forces at Persian Gulf war has drowned the lessons of the Vietnam war learnt by US Armed Forces. All the technical advantages of USA at Vietnam could not win the war for them.

AIM

9. The aim of this paper is to discuss the advancements in communication technology, their relevance in our Armed forces and consequent impact on our concepts and doctrine as to how we should conduct warfare in this environment.

SCOPE

10. The study has the following scope:-

- (a) Latest Communication technologies available.
- (b) Impact of the technologies on how war is to fought.

(c) Impact on Command and Control and Doctrine.

LATEST COMMUNICATION TECHNOLOGIES AVAILABLE

11. Some of the latest communication technologies available today are given below:-

(a) Personal Communication Network (PCN)

(b) Personal Communication System (PCS)

(c) Digital Cellular Radio Mobile Sys.

(d) Wireless in local loop.

(e) ISDN.

(f) **Tele Services**

(i) Voice

(ii) ISDN Facsimile.

(iii) Teletex.

(iv) Videotex.

(v) Video phones.

(g) **Value Added Services**

(i) Telemetry such as burglar alarm, fire alarm etc.

(ii) E-Mail, Voice-Mail and Video-Mail (B-ISDN).

(iii) Electronic Money.

(iv) Inter and Intra Nets.

(v) Electronic Fund Transfer.

(vi) Other Data Services e.g.

(aa) Inventory Sys.

(ab) Financial Information Sys.

- (ac) Reservation for Hotels/Airlines.
- (ad) Medical Information sys.
- (ae) Voting and Opinion polling.
- (vii) Kiosk services for weather forecast, stock exchange information etc.
- (viii) Video conferencing.
- (h) Voice mail/stored voice.
- (j) Bulletin board services(BBS).

12. **Optical Fibre systems**

- (a) Synchronous digital hierarchy (SDH).
- (b) Asynchronous transfer mode (ATM).
- (c) Advanced coherent lighthwave technology.
- (d) Photonic Network.

13. **Video systems**

- (a) Video compression
- (b) High definition TV(HDTV)

14. **Components.** Nano electronics.

15. **Satellite Communications**

- (a) Survivability and security of satellite communications.
- (b) Time assigned speech interpolation (TASI).
- (c) Spread spectrum system.
- (d) Single carrier per channel (SCPC).

(e) Spread spectrum multiple access/code division multiple access (SSMA/CDMA).

(f) Mobile satellite comn.

16. **Computers**

(a) Text of speech synthesis.

(b) Image technology and multimedia.

(c) Fault tolerant computing.

(d) Virtual reality.

(e) Neural networks.

(f) Fifth generation computers.

(g) Optical computers.

(h) Voice activated computers.

(j) Screen touch commands.

(k) Data security.

IMPACT OF LATEST COMMUNICATION TECHNOLOGIES ON WARFARE

Advantages Due to Technological Advances

17. Some of the improvements in the way future wars would be fought are:-

(a) Improved information integration speeds the decision making cycle by processing and distributing information more quickly.

(b) Information is force multiplier. It allows efficient allocation of scarce assets and improves target acquisition.

(c) The new systems provide fuller knowledge of enemy hardware, troop concentration, environment and terrain. Deny the same to enemy.

(d) At tactical level real time information on troop and force movements may permit more rapid and effective offensive or defensive actions. The side that loses its ability to detect the enemy and friendly situation will lose maneuver freedom.

(e) Information warfare techniques support "Information" attacks on political and economic infrastructure.

(f) Increase a unit's flexibility and agility.

18. The following examples illustrate where information technology could enable Military operations by the turn of this century :-

(a) Today, tactical radio communications networks exist separately with no automatic routing or interconnection between nets. On the future digitized battlefield, a tactical internet capability will enable direct communications among and between virtually all user. This could enable a whole new level of horizontal integration, coordination, and synchronization that will coexist with the current vertical system.

(b) Direct broadcast satellites enable wide access to information at various echelons in real time or near-real time. This in turn enables a new level of empowerment and self initiative for lower echelons.

(c) Image compression and transmission technologies will allow transfer of images and video from numerous sensors and platforms, enabling better understanding of battlespace for planning , rehearsal, and mission execution.

(d) Finally, multimedia technology will enable three-dimensional presentation of imagery and graphics to help commanders visualize their battlespace for more effective training, planning, rehearsal and execution.

Limitations

19. Some of the limitations and risks due to improvements in information technology are :-

(a) The improvement of communications at the disposal of political leaders and military commanders has always carried the danger of disrupting the chain of command. Senior commanders, with a real time picture of the battlefield, will be tempted to interfere in lower echelon decision.

(b) Stifling of initiative in subordinate commanders may be another problem. Even if the subordinates are not required to coordinate details with senior commanders, the junior leaders may be inclined to do so simply because the

communication means are available. This could compromise initiative and undermine the effectiveness of command.

(c) Another danger is data overload. The danger now is that commander will be so bombarded by such a large volume of even unessential data that it will obscure the real issues that have to be interpreted. This is subjective and depends upon the intellectual capability and personality of commander and his staff. For example arguments are still raging about accuracy of bomb damage assessments in Gulf War. It is reported that a group of senior Marine Corps officers of US Marine Corps led by the Assistant Commandant of the Corps visited New York Stock Exchange to learn how brokers absorb, process and transmit the vast quantities of perishable information that are the life blood of the financial market.

(d) Decision making tends to get bogged down due to "paralysis of analysis". Commanders wait for the last piece of intelligence that never comes.

(e) Rapid proliferation of information technologies particularly reduces the ability to achieve surprise.

(f) Improved information connectivity and distribution increase tension between operational security and effective planning.

(g) Vulnerabilities have increased as commercial tele-communication networks and military networks are linked and interdependent. This can be easily targeted by enemy.

(h) Given time, technology gap can be closed by enemy suddenly.

(j) Technology extends the time needed to develop new weapon systems reducing the speed with which they could be replaced in time of war.

(k) Is it better to have a larger force with lower technology or a smaller one tied to advanced systems? The larger force is more expensive in terms of maintenance while the smaller one costs more to procure.

(l) Though the command communication have become both increasingly important and vulnerable, disrupting enemy communication could be counter productive, if they have been yielding valuable intelligence or if the enemy then resorts to communication that are not susceptible to monitoring.

(m) Gulf War gave a wrong impression that war can be nearly bloodless. All the munitions used in Gulf war were not PGM. Only 6.2 percent of munitions used in Kuwaiti Theatre of Operation in DESERT STORM were precision guided.

(n) Possession of superior technology does not ensure its effective use. This can be countered for example, chaff used against radar.

(o) Non battle tested equipment may not perform to expectations. Performance of patriot missiles was a butt of joke in Israel.

Communication Requirements of the Battlefield.

20. War in Information Age would depend on electromagnetic spectrum dominances. This is as important as say air superiority. Sophisticated communications systems and data networks are the backbones on which Information Warfare would be fought. With the expertise available today both inside the services and outside in business, phenomenal communication infrastructures /can be built up which some time earlier one could not even imagine.

21. Some important aspects of communications which should always be kept in mind are :-

(a) The bandwidth used should have the capacity and flexibility for the full flow of data. Commander's critical information requirement must be met. Do not send critical information over jammable fragile media. Do not send high volume information over narrow, slow media. In the communications bottlenecks do not choke decision maker's communication with less important transmissions.

(b) The communication systems should be robust, Off the shelf equipment has its own vulnerabilities, fragility and limitations.

(c) Communications systems should be electronically survivable. Proliferation of various means would increase survivability. Hiding of command control and communications systems, use of small, movable COMSAT receivers, burying of field and fibre optic cables, use of redundant pathway, keeping a back up communication plan, upgrading of communication systems would go a long way in making the communication systems survive in hostile electro magnetic environment. Avoid C3 standardization. Full standardization promotes vulnerability.

(d) The Command, Control Communication and intelligence system must be interoperable. That is why the system is called C⁴I² system. The incidents at Granada, where a US soldier could not get a fire support message passed to the US Navy ships lying in sight off shore and he had to call from a phone booth to Pentagon to get the same and the Air Task Order (ATO) in the Gulf war had to be printed, copied and carried to the Navy by hand because communications were incompatible, are well known. Such incompatibility can cause disasters in next war.

(e) All armies acknowledge the need to maintain communications with the flanks and higher formations. In practice the link to higher and lower formations are given the most importance while the flank communications is given lesser priority. This is bound to happen in a hierarchical system like army because most orders and information flow from higher to lower formations. If communication is lost there is no alternative other than to re-establish it. However, in information age when hierarchical systems are going to be replaced by networked systems, commanders must maintain communications with the flank units and through them to other units to update the common ground picture.

(f) In a hierarchical organisation as the size grows organisational structures become more complex with greater layers. The organisations tend to be unresponsive, bureaucratic and top heavy. With the introduction of modern communication means organisations all over the world are getting restructured and redundant management layers are being removed. The case of restructuring our defence forces organisations in view of the advances in information technology to provide more responsive organisations need to be looked into.

Human Resources Development.

22. Current Information Technology systems can move information around automatically, change and highlight specific aspects and present same facts in various ways without human involvement. The user, whether a commander, staff officer or administrators sometimes gets confused. The Information Technology tool is available which should be understood and used by all. Personnel of all arms need to be trained to operate and exploit the system. There is no way out but to learn basic minimum requirements to function in today's IT environment.

23. Information technology and precision weaponry will not necessarily guarantee success on future battlefields. Commanders must become experts on using information. By knowing the limitation of a sometimes coarse systems and the opportunities provided by Information Technology they can use it as a combat multiplier.

24. Change of Mindset. Eliot A Cohen writes "The new technologies will increasingly bring to the force the expert in missile operation, the Space General and the Electronic Warfare wizard - none of them a combat specialist in the old sense and a fair percentage of them, sooner or later, female. Military organisations still need, and will always need, specialists and its physical and intellectual demands have grown. The mindset of military higher echelons also have to change to accommodate the push button soldiers and their General and should be given their dues". The tooth to tail ratio would reduce drastically. The United States sent 5,00,000 troops to the Gulf and there were 2,00,000 to 3,00,000 backup troops. The

tail included the real 'stars' of Gulf War , American Software Soldiers, the computers programmers mostly civilians. In future battlefield the combat arms soldier "is not a mere ammunition mule and bullet hose holder. He understands both mechanised and foot soldier tactics. He is skilled in the operation capabilities of helicopters and fixed wing aircraft, for he is most often the controlling agent. Directing aircraft means he understands antiaircraft weapons. He is skilled in geometry and navigation to direct mortars and artillery... Armor and anti armor, mine and countermine weapons and tactics, use of demolitions, computers, motor vehicles, laser designators, thermal sights, Satellite communications, gears are part of his kit". To operate in this environment a soldier has to be well educated, intelligent and of high quality. The Gulf War was a "high tech" War in which the human element in combat was eliminated is a fantasy. The forces sent by the allies to the Gulf War was the best educated and technically expert army ever sent to battle. Over 98 percent of US Army's all volunteer force at the time of Gulf War were high school graduates. Many were better educated than that.

25. Although many things in the world have changed, war in the future will continue to require well-trained, well equipped men and women who are willing to put their lives on the line and do the hard, dirty work of war.

26. Today's Commanders and Staff may be provided with the following:-

(a) **Intranets**. Respective branches and staff maintain servers loaded with constantly upgraded information on their area of responsibility. It would require robust communication support.

(b) **E-mail**. It is likely to be the most assured way of ensuring that orders get to the recipient.

(c) **Direct Broadcasting Satellites**. Fragile communication in the most intense stage of the battle can be overcome by use of Direct Broadcasting Satellites(DBS). Commanders would use narrow band, terrestrial, Combat Communications to call for information which is delivered from powerful satellite stations in the home base, in accordance with a predetermined schedule, direct to the terminal and display unit at the requesting HQ.

Ops Room Capabilities

27. The quality of information available to a commander should improve tremendously. The following would happen:-

(a) **Paperless Ops Room**. Future Ops Room would not be map free or paper free office, but paper used would be much less. Information will appear directly on the screens.

(b) **Data Fusion.** Commander with access to number of servers maintained by respective branches or staff may need information fusion at ops room as well as presentation aids.

(c) **Hypertext.** Information is likely to be presented in hypertext format i.e., click on the word and get more information. Staff would have to build hypertext structures which is a labour intensive task.

(d) **Virtual Reality.** This may help commanders and staff to absorb complexity.

(e) **Human Computer Response.** Presently for our interaction with information systems we are limited to keyboard and screen. More human response would be forthcoming with speech recognition system.

(f) **Telepresence.** Remote controlled devices have started operating to deal with explosives. It would make its presence felt in mine clearing, recce and video conferencing.

28. **Information Management.** Staff officers and clerical staffs in formation/unit headquarters will require to develop skills in Information Management. It is in this area that operational needs and technology interact most intimately. It is for the operational staff to decide what information is needed by whom, how it should be presented, what is the pay off between speed and accuracy, what risks to be taken on security, who owns the information, who has the power to change and responsibility to upgrade or the access rights to read.

29. The final requirement will be commanders who are unfazed by information in terabytes. The staff at fmn/unit HQ should be divided into following:-

(a) The Information Manager Responsible for the content and structure of the information and the channels and associated management structure for information dissemination.

(b) Cyber Librarian Maintains the Integrity of information and ensures that information structures support the plan of the Information Manager.

(c) Web Master Ensures the tools for using the technology eg the browsers and search engines are readily available and understood by all who need them.

CONCEPT AND DOCTRINE

30. Doctrine lies at the heart of a Military Forces professional competence. It is the authoritative guide to how forces fight wars and conduct operations other than war. Never static, always dynamic, doctrine is always rooted in the realities of the current

capabilities. At the same time, it reaches out with a measure of confidence to the future. Doctrine captures the lessons of past wars, reflects the nature of war and conflicts in its own time, and anticipates the intellectual and technological developments that will bring victory now and in the future.

31. Throughout history, military doctrine, organisation and strategy have continually undergone profound changes due in part of technological breakthroughs. Today's information revolution reflects the advance of computerised information and communication technologies and related innovation in organisations and management theory. Sea changes are occurring in how information is collected, stored, processed, communicated and presented and in how organisations are designed to take advantage of increased information. Advanced information and communication systems properly applied can improve the efficiency of many kinds of activities. But improved efficiency is not the only or even the best possible effect. The new technology is also having a transforming effect, for it disrupts old ways of thinking and operating, provides capabilities to do things differently and suggests how some things may be done better, if done differently.

32. This form of warfare may involve diverse technologies – notably for C³I for intelligence collection, processing and distribution, for tactical communication, positioning and identification friend or foe (IFF); and smart weapon systems. It may also involve electronically blinding Jamming, deceiving, overloading and intruding into an adversary's information and communication circuits.

33. The information revolution calls for organizational innovation so that different parts of an institution function like interconnected networks rather than separate hierarchies. Moving to networked structure may require some decentralization of command and control. This may well be resisted in light of the view that the new technology will provide greater central control of military operations.

34. In view of the advancements in communication technologies new doctrines are to be developed about what kind of forces are needed, where and how to deploy them and what and how to strike on the enemy's side. How and where to position what kinds of computers and related sensors, networks, databases etc. may become as important as the question used to be deployment of say air force and their support functions.

New Opportunities.

35. New communication technology applications has begun to transform the business world both operationally and organizationally. The government world is moving slowly in adopting the information technology revolution. One might expect the military world to lag behind both the business and government worlds, partly because of its greater dependence on hierarchical traditions.

Span of Control.

36. For example, can we remove Corps HQ and have only Div HQs under a Theatre Command ? Toefflers stated "until recently 10,000 - 18,000 man division was thought to be the smallest combat unit capable of operating on its own for a sustained period. It would typically include three or four brigades, each with two to five battalions staff. But the day is approaching when a capital intensive third wave brigade of 4,000 - 5,000 troops may be able to do what it took a full size division to do in the past" Currently the US Army is contemplating dramatic organisational changes. In a testimony before the Senate Armed Service Committee, US Army Chief of staff General R Sullivan stated, " We must continue restructuring our organisations, both tactical and administrative, to take full advantage of the ongoing technological revolution. The time has come to redesign the force for the 21st Century and the Army has started that process. We will call the force, Force XXI."

37. In view of the possible extension of integrated data and communication links to lower and lower levels in the chain of command an opportunity has come to reshape the hierarchy of our force structure by increasing the span of control either at Corps or Divisional level and thus eliminate the Divisional Headquarters or the Brigade Headquarters.

Command and Control.

38. The command or control dilemma is real. The confusion starts with trying to establish a common frame of reference on exactly what command and control means. In future wars, characterised by increased operations tempo, the correct command and control operation may be that of command or control. Centralised control exercised through hierarchical organisations reflects old and dangerous thinking against future enemies operating at a faster decision making cycle. Greater access to shared information and decentralised decision making are key to operating at the tempo required in information age warfare. If Indian Armed forces acquire the information technology needed to operate at faster tempos, we should have the correct organisational orientation and procedures to take advantage of it. The command and control capability adopted by a nation should reflect and support those national characteristics that are its greater strength. Integrity, Initiative, and esprit de corps are our army's strengths, and the command style most appropriate for us should be designed to capitalize upon these characteristics. Each age of warfare required different treasured capabilities. In agrarian-age warfare, strength and cunning are valued. In industrial-age warfare, organisation and discipline were valued. In information-age warfare the treasured capabilities are knowledge and creativity. We must have the organisational orientation to take advantage of these capabilities.

RECOMMENDATIONS

39. Technology is a tool and humans decide how they will organize and how they will use the tools available, A screwdriver can be used as an icepick and one can pound nails with a laptop computer. Information technology-computer machines and

communications devices –can enable us to fight more effectively. If fighting more effectively is the goal, we should decide how to organize to use these new tools to our best advantage. The following is recommended :-

(a) We must establish useful definitions to clarify “command and control”. We can eliminate considerable confusion by abolishing the use of “command and control” and reinforcing the importance of “command”.In its present context, “command” embraces planning, organising, directing, coordinating and controlling. Command has also proven to be timeless notion in spite of organisational changes and technological advances. We must resist efforts to hang additional attributes on the function of command because it dilutes the most critical component of war; Command.

(b) Information, by its very nature, is most useful when not hierarchically controlled. A characteristic of military hierarchies is control of information. We must take advantage of networked organisational orientation in providing access to shared information at all levels of command. Shared information helps reduce uncertainty and improve a commander’s decision making cycle. Given the danger of information overload, new technological innovations such as computer smart agents and data mining will allow commanders to tailor their information gathering capabilities to meet their specific needs. Shared information gathering allows for increased operations tempo.

(c) Decision making is most effective in a flattened hierarchical organisation. Eliminating layers of command provides the means to operate at a higher tempo. Decentralised control also encourages innovation and initiative at the lowest levels of command and promotes morale.

(d) We must reexamine the doctrine of centralised control, decentralised execution against an information-age adversary. The present concepts are a product of hierarchical organisations and centralised control, perhaps the last vestiges of excessive concern over “Independence”. While effective in industrial – age warfare, the limitations centralised control places on timeliness, flexibility, and tempo create potentially serious problems should we face an adversary operating at a faster operations tempo. The same technology that promotes greater centralised control can also apply to decentralised control.

CONCLUSION

40. "Changing any military's doctrine, however, is like trying to stop a tank armour by throwing marshmallows at it. The military, like any huge modern bureaucracy, resists innovation - especially if the change implies the wngrading of certain units

and the need to learn new skills and to transcend service rivalries. To define a new doctrine, to win support for it both in the armed forces and among politicians, and then to actually implement it with trained troops and appropriate technologies is a tremendous task, and no one man, General or not, could possibly hope to accomplish it. It would take a campaign - one in which ideas would be the bullets."

41. The competition for information is as old as human conflict. Nations, corporations and individuals each seek to increase and protect their own store of information while trying to limit and penetrate the adversary's. However, around 1970 extraordinary improvements in the technical means of collecting, storing, analysing and transmitting information started happening. This information revolution is showing no signs, of slowing down. This improvement of information technology will have dramatic impact on the battlefield and we, in the Armed Forces have to look into the great potential of this emerging technology. However, one should not forget that regardless of different technological levels of combatants on the future battlefield the side which have better leadership, better quality soldiers and unit training will be the winner.

BIBLIOGRAPHY

1. Colin L Powell, Information Age Warrior, Byte, July 92, pg 370.
2. RL Dinardo and Daniel J Hughes, Some Cautionary Thoughtson Information Warfare, Air Power Journal, Winter 1995.
3. US News and World Report, "The Information Technology," May 2, 1994.
4. Lt Cdr Jeffry A Harley, Information, Technology and Centre of Gravity, Naval War College Review, Winter 1997.
5. Eliot A Cohen, A Revolution in Warfare, Foreign Affairs, Mar-Apr 96.
6. Maj Gen David L Grange and Col James A Velly Information Operations for the Ground Commander, Mil Review, Mar-Apr 1997.
7. Alvin and Heidi Toffler, War and Antiwar, Little Brown and Company, PP 76-79
8. Col Owen E Jensen, Information Warfare, Principles of Third Wave War, Air Power Journal, Winter 1994.
9. Toffler, ibid , p 76.
10. Ibid.
11. General Dennis J Reimer , Soldiers are Our Credentials, Military Review, Sep-Oct 1995, p 13.
12. General Gordon R Sullivan, A Vision for the Future, Military Review, May-Jun 1993.
13. Fact File : India and the World, The Hindu, 30 Jun 1997.
14. Maj Gen WJP Robins, OBE, Information Age Operation, Rusi Journal, Jun 97.
15. Tofflers, ibid, p 52.

Published in MCTE Journal 1999.