Emerging Technologies and their Impact on War Fighting

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> The size of the Army matters but it is the technology that wins war.
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> — Harry S. Truman

The truism in the above statement is borne out by centuries of military history and warfare. At the height of Roman Empire, Roman legions armed with arrows, long-staffs and shields used precise steadfast formations to devastate the massive, but ill-equipped barbarian hordes. The invention of stirrup in the 6th Century gave horsemen an astounding ability to use their mount as a lethal weapon by allowing the horse's mass and speed along with the devastating thrust of their spears. In 1232, during the battle of Kai-keng, the Chinese repelled Mongol invaders with the first known use of rudimentary rockets powered by gun powder, called 'Arrows of Fire.'

Closer to our times in the Gulf War of 1991, precision guided smart bombs, ground hugging Cruise Missiles and invisible stealth fighters forced the massively equipped and numbered Iraqi Army to its knees against the Allied forces. The pace of technology in re-vamping the battle space has continued unabated as new and innovative methods of war fighting keep getting invented on the growing wings, reach and prowess of cutting-edge technologies.

It is the ever-changing face of the future battlefield and consequent war fighting that drives a regular feed of new and innovative technology in the field. The constraint of the scope of this paper does not allow a detailed exposition on

the emerging changes in the future battlefield, per se, therefore only some signature nuances are put down in point form below:

- Complex Irregular Warfare - often using non-traditional modes.
- Not restricted to the traditional remote/ uninhabited/sparse/ mountainous or high altitude area but unfolding in urban populated landscape of built up areas pregnant with issues of collateral damage.
- Covering a wide spectrum from terror threats, insurgencies, asymmetric warfare and limited or intense large scale conventional war with the possible overhang to the remote but possible Nuclear Biological and Chemical Warfare.
- Short notice, short duration war fought with high tempo and intensity.
- on linearity, dispersion and decentralisation in the conduct of operations.
- Asymmetric warfare employing Special Forces, insurgents and terrorists.

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A variety of cutting edge surveillance systems duly backed by satellites and a plethora of electro-optics are providing ever increasing battlefield transparency in 3D spatial dimension. The ever increasing reach of 'stand-off' strike capability coupled with the beyond visual range capability of the 3D surveillance means are providing increased survivability to combat vehicles prosecuting strikes on targets either from air or ground as most of them manage to remain away from the effective hard kill range of defender's combat means. Added to this, a plethora of smart and intelligent and severely lethal ammunition is providing increased range, reach and precision strike capability making war fighting possible in urban landscape with minimum collateral damage besides making the combat zone, more lethal, deeper and wider.

Militarisation of space, which is currently growing will prove to be a pivotal aspect in the future battlefield. The ultimate high ground is increasingly being exploited to base global look-see surveillance systems, anti satellite systems and now ballistic missile defence kill vehicles. Ground-based (high power, long range) surveillance systems are being seamlessly integrated with space-based systems and technology to provide an extended kill capability in space duly backed and complemented by resources on ground.

Information Warfare is riding on the wings of such cutting edge technologies has become a major force multiplier and a battle-winning factor with its multiple-

mode manifestation as cyber-warfare, cyber-terrorism, psychological warfare and the like. Evolving technologies in this field are resulting in transition from information warfare to information-control through information-dominance. Net centricity is making possible information superiority enabled concept of operations that aims to increase combat power through networking of sensors, decision makers and shooters. This achieves shared awareness, increased speed of command, higher tempo of operations, greater lethality, user survivability and a degree of self synchronisation.

When deliberating upon the future battlefield, it is pertinent to highlight that 'soft-kill' has complemented the erstwhile 'hard kill' capability of various weapons. The effectiveness of such kills through electronic/ electromagnetic incapacitation of intended targets is becoming more and more effective due to the ever-increasing dependency of combat and combat support means on electromagnetic muscle (electronics, computers, information technology, information technology enabled services, etc). The chapter would focus on technologies relevant for Battlefield Transparency and Situational Awareness; Stealth technologies; Precision Guided Munitions (PGMs); Laser-based weapons such as High Power Microwave (HPM) weapons and Charged Particle Beam Weapons (CPBW).

Battlefield Transparency and Situational Awareness - The focus of new technologies in this field is to address the 'Fog of War'. The spectrum of devices extends from space-based sensors to surveillance devices integrated in manned aircraft/ Unmanned Aerial Vehicles (UAVs) and sensors on the body of the soldier; all inputting in one way or other through a critical system of filters to the decision-maker who is technologically empowered to monitor virtually everything that is going on in the area of interest, thereby, dramatically improving battle-space surveillance resulting in complete situational awareness. A glimpse of some specific technologies in this field is as under:

- A number of geo/ sun-synchronous Space Based Infrared Systems (SBIRS) and active Radar Satellites (RADARSAT) carrying earth-observing Synthetic Aperture Radar (SAR), or SARs, (belonging to US, Russia, China and Germany) are providing a global surveillance capability in the field of strategic missile attack warning, as well as, directing own space based kill vehicles on to incoming missiles in boost/ ascent phase or are active in the anti satellite kill domain. The capability of SBIRS/ RADARSATs is being augmented by integration with aerial command posts and long range ground based warning sensors like Precision Acquisition Vehicle Entry-Phased Array Warning System (PAVE-PAWS) and Mobile Sea Based X Band radar, in case of USA and Over the Horizon-Backscatter (OTH-B) radars in case of China.

- Three types of radars are being used in the Space domain; SARs as described above, scatterometers for high value operational meteorology and Cloud Satellites (CLOUDSAT) for precipitation studies.
- Another technology called ROVER (Remote Operations Video Enhanced Receiver) system allows the ground forces to see what a UAV/ manned aircraft is seeing in real time.
- While relevant data generation is one function, its real time dissemination is a bigger challenge. Technology currently provides us an array of Data Dissemination System (DDS), e.g. Optical Radio Frequency Communication Adjunct (ORCA) is one such technology, which provides an alternative to the congested use of radio frequency spectrum through a high bandwidth network.
- To provide the war fighter affordable, ever-present intelligence, reconnaissance, and rapid communication connectivity over the entire battle space, Lockheed Martin of US have matured a technology of High Altitude Airship. It is an unmanned, untethered, lighter-than-air vehicle designed to operate above the jet-stream in a geo-stationary position to deliver persistent station-keeping as a surveillance platform (a capability at par with satellites). The High Altitude Airship can also integrate re-configurable multi-mission payload suites. The technology is ready for flight integration.
- For continuous streaming of battle space data, super-steady hovering platforms (Dragon Flier X6 Helicopter–Canada) are at the cutting edge. Besides this, a variety of UAVs with Vertical Take Off and Landing (VTOL) features (Campcopter S-100 VTOL UAV) and a capability to operate Beyond Line of Sight (BLOS) guided by satellites through Geographical Information System (GIS) network stations (HERMES 900 Medium Altitude Long Endurance Unarmed Aerial Vehicle) are becoming realities. Cutting edge unmanned vehicles also have the capability of Independent Automatic Take Off and Landing (IATOL) at remote, un-reconnoitered airstrips.
- In the field of surveillance/ fire control/ missile guidance radars, the current entry level is 3D with capability of Multi-Sensor Tracking (MST), Track While Scan (TWS) and a strong arsenal of Electronic Counter Counter Measure (ECCM) suite. Contemporary technology is also moving from passive to Active Electronically Scanning Array (AESA) radars and radars having a look capability beyond the line of sight horizon using Over the Horizon (OTH) technologies.

Stealth technologies – Such technologies are fast maturing into adoptable means providing enhanced survivability to kill vehicles/ personnel in hostile

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environments. The drive of technology in the stealth warfare domain is towards the following directions:

- Reducing the radar cross section of detectable objects by using a variety of methods to include radar absorbent paints, smooth surfaces and specially angled surfaces (faceting) etc.
- There is a technology of 'active-cancellation' which aims at returning the incident radar signal in a slight 'out-of-phase' mode thus cancelling the incident signals and ensuring that the radar illuminating the target does not get the target signal. Stealth aircraft like B-2, F-117, F-22A, and possibly F-35 use this technology.
- A variety of Radar-Absorbent-Materials (RAMs) are in use as stealth tools. One such paint is called the 'iron ball' paint which contains spheres coated with carbonyl iron or ferrite. This has an effect of converting the incident radar electromagnetic energy into heat energy, which is transferred to the aircraft and dissipated, thus, making the target near invisible.
- Another technology in RAM field is foam absorber material. This material in stealth targets, attenuates the incoming radar signal thus weakening it in strength to be returned to the illuminating radar and making the target invisible.

Precision Guided Munitions (PGMs) are another growing area of technology. They encompass smart and brilliant weapons to include a host of systems from missiles to individual warheads. Enabled with on-board pre-fed intelligence and guided all-the-way by Global Positioning System (GPS) and Geographical Information System (GIS), such munitions have the capability to hit small targets from thousands of miles away (US Tomahawk Cruise Missiles can hit a small room from a distance of 1600 Km). The range of standoff weapons has gradually increased from 10-20 Km to 100-200 Km (US Joint Direct Attack Munitions (JDAMs) - 100 Km). Advanced Hit Efficiency and Destruction (AHEAD) airburst Army Air Defence ammunition is innovative ammunition where intelligence (muzzle velocity, time of flight) is fed into every single round to increase precision and accuracy. The hit pattern of such rounds in the form of an outward spreading centrifugal spiral enhances the kill effect by many orders of magnitudes.

The technology is driving in three different weapon domains, namely LASER based weapons, High Power Microwave (HPM) weapons and Charged Particle Beam Weapons (CPBW).

Cutting edge weapon based applications in LASER systems are as under:

- Quick Reaction System- Starting from its earlier versions of the Mobile

Tactical High Energy Laser (MTHEL), a US-Israeli program that was designed for the soft-kill of incoming tactical munitions, M/S Northrop Grumman of the USA is now developing a quick reaction solid-state LASER system named HORNET (Hazardous Ordinance Engagement Tool Kit). This quick reaction system has been designed to defeat small supersonic missiles targeted at aircraft landing and taking off from military and civilian airfields.

- LASER Area Defence System (LADS) - Another system based on solid-state LASER technology is LADS under development by M/S Raytheon Missile System of USA. The weapon is designed to engage and destroy rockets, mortars and small missiles with bursts of LASER light. The system is mounted in the carriage of Phalanx Close-in Weapon System (CIWS) which has a 20 mm electrically-powered Gatling Gun.
- LASER Avenger System- Another solid-state LASER is under development by M/S Boeing Missile Defence System, USA. This infrared LASER system is designed to engage and destroy the smaller variety of UAVs that have proved to be so difficult to destroy by conventional surface to air missile systems. The system is also likely to be effective against incoming missiles and precision guided munitions (PGMs).
- High Energy LASER System-_One of the major problems in LASER based soft kill is the requirement to generate huge power for the LASER beam to be incapacitating at long ranges. One such system is being developed by M/S Northrop Grumman of USA. This system named Skyguard, is a high energy LASER defence system where a high energy lethal LASER beam is generated through chemical LASER generator. The system with its long range is effective in the soft kill of short range ballistic missiles, cruise missile, UAVs and other short range systems.
- Leap Ahead Technology- M/S Northrop Grumman is also developing a Compact High-Power Solid-State LASER (CPSSL) for multiple military missions including protection of vulnerable areas/ vulnerable points (VAs/ VPs) from precision strikes by cruise missile, UAVs, and manned aircraft. Presently, the system is a high power 15 Kilowatt solid state system. It is intended to push the system power up to 100 Kilowatts using amplifier chains. Going towards the future, multi-megawatt gas dynamic LASER based Directed Energy Weapons (DEW) are also being developed (High Energy Laser Experimental-HELEX). In such systems, high energy beams are produced by burning of combination of gases and generated beams are focused using large mirrors on adjustable scaffoldings.

Other areas of technological innovation include High Power Microwave (HPM) Weapons, also referred to as High Power Radio Frequency or Ultra Wide Band weapons. Such weapons are capable of producing intense beam of radio frequency radiations. A typical component of an HPM system will include electron beam accelerator capable of providing high voltages (200 Kilovolts to several megavolts), high currents (1-100 Kilo amperes) and short pulses (10-1000 nanoseconds). A typical weapon package will comprise of an electric or explosive prime power source, a radio frequency generator and an antenna beam direction. The power levels being generated lie in the range of 100 Megawatts to 10 Gigawatts. Such power, when incident upon a target is capable of carrying out adiabatic burn-out of electronic components and / or detonation of electro-optical devices. This massive influx of electromagnetic energy incident upon the target simply causes total burn out of all electronic and electromagnetic circuits/components. This is also sometimes referred to as 'frying of electrons and electromagnetic components'.

Yet another soft-kill weapon being tried out at the horizon of technology is Charged Particle Beam Weapons. The signature feature of these weapons is contained in the form of kill energy they produce. Eventually, the concept is to accelerate huge quantity of sub-atomic charged/ neutral particles using Massive Particle Accelerators so as to achieve astronomical speeds (1,86,000 meters/ second). Since the energy of the beam is the aggregate energy of the rapidly moving particle beam, the same develops tremendous penetrative capability. A reference to such energy is given as 'lightning bolt' and the beam, itself, is often referred to as 'bolts.' Such a beam when incident upon a target can cause catastrophic devastation by destroying (altering) the internal/ material coherence of the target material and exploding the same by suddenly transferring massive amount of energy into it. The kill effect of such a weapon is through a generation of electromagnetic pulse having catastrophic devastating effect on the target material and its electronics.

The future battlefield is actually getting shaped by the galloping pace of technology. It is pertinent to keep a track of latest technologies and match their utility with our needs. The future belongs to technology and innovativeness and any army that fails to adapt with the changing environment is bound to restrict its victory in the future battlefield.

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