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SECURITY, ECONOMICS AND THE ENVIRONMENT

CURRENT FACTORS AND PLAYERS

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ASPECTS OF THE SOUTH ASIAN SITUATION

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Nuclear Deterrence

THEORY, PRACTICE AND CHANGING CONTOURS

Nuclear deterrence is a hazardous affair premised upon a credible threat of retaliation. The underlying assumption is that the fear of assured destruction would persuade enemies of the futility of using nuclear weapons. The moot requirement of nuclear deterrence is the survival of retaliatory arsenals. A state under attack must be able to guard its ability to strike back instantaneously and this could happen only if its retaliatory systems survive. In past decades, the survivability of retaliatory arsenals was almost assured as nuclear deterrence systems were large, dispersed and easier to hide and protect. However due to changing technological contours, first strike weapons have shrunk in size, surged in stealthiness and increased in accuracy. The changes are of such magnitude, extent and variety that they undermine the very foundations of nuclear deterrence.

ATTAR RABBANI

INTRODUCTION

The fate of nuclear deterrence is tied to the survivability of retaliatory systems. A robust nuclear deterrence rests on the ability of states to secure nuclear arsenals and the forces that organise them from enemies. For this reason, states have become preoccupied with the nitty-gritty of retaliatory strategies. While the survivability of retaliatory systems was taken for granted until a decade ago, today their survival is in doubt. Technological trends epitomised by the revolutionary power of computers have made retaliatory arsenals susceptible. This does not mean that all nuclear arsenals have become equally vulnerable—countries that lead technological revolutions circumvent the challenge more effectively than others. Highly effective devices such as guidance systems, auto-piloted missiles systems, data retrieving, processing and transmitting systems, unmanned drones, robots, etc have fast depleted states' ability to protect retaliatory systems. "Hardening" and "concealment"—two widely used designs are no longer as effective as they once were.

The growing susceptibility of nuclear arsenals will have phenomenal repercussions. Vulnerable arsenals reduce the possibility of disarmament, as states are more in favour of it when their own prized weapons are fully secure. However, technological trends have eroded the credibility of survival strategies. Advanced sensors, for instance, now enable states to track, trail and crack enemy arsenals, thus reducing their readiness to control arms. Moreover, the growing vulnerability of nuclear arsenals may persuade states to diversify their retaliatory forces. As nuclear arsenals become prone to attack, some states may multiply retaliatory resources. In such a situation, other states would have no choice but to follow suit with the technological breakthroughs. In addition, the growing vulnerability of nuclear weapons will fuel a new arms race. As states improve their arsenals, delivery systems, command architectures and force combinations, they will invariably jeopardise adversaries' relevant arrangements and possibly make them undertake a slew of countermeasures. The history of the development of nuclear weapons in the United States of America (US) and the Soviet Union/Russia has more or less been the history of surpassing the adversary's technological breakthroughs. To remain relevant in the game other nuclear powers, notably China, France and the United Kingdom (UK) have done little else but follow the technological trends of the superpowers. Even the new entrants—India and Pakistan—have only followed one another in terms of sophistication of devices, delivery systems

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and operational doctrines. Taken together, these repercussions will jeopardise not only the credibility of the survival of retaliatory systems but also the worthiness of the nuclear deterrence theory.

THE THEORETICAL FOUNDATION

The theory of nuclear deterrence revolves around two co-dependent postulations—the costs of nuclear attacks dissuade the initiation of nuclear strikes and nuclear weapons give states (both the powerful and relatively weak) the ability to inflict unacceptable damage. (Robert Powell, *Nuclear Deterrence Theory: The Search for Credibility*, Cambridge: Cambridge University Press, 1990) That is, the costs of using nuclear weapons outweigh the benefits and should aggressors initiate nuclear strikes, they would be assured of unacceptable damage. The inference is that nuclear weapon states will not attack other such states and thus nuclear weapons may be regarded as instruments of perpetual peace. The nuclear theory is also premised on the logic of deterrence. That is, nuclear states enjoy "fundamental" security and may manage anarchy far more successfully than non-nuclear states. The imperative requirement is the ability to deploy retaliatory arsenals, which must survive adversarial strikes. States are then assured a long spell of fundamental security and need not fear conquest. (Robert Jervis, *The Meaning of the Nuclear Revolution: Statecraft and the Prospects of Armageddon*, New York: Cornell University Press, 1989, p23) In other words, nuclear states need not worry about the relative balance of power, engage in the arms race and compete for alliance partners or strategic territory.

However, the theory of nuclear deterrence is not unblemished. (Ward Wilson, "The Myth of Nuclear Deterrence", *Nonproliferation Review*, vol15, no3, 2008, pp421–39) Had the theory been infallible, there would have been no extensive arms race, competition for allies or control of strategic territories between the US and Soviet Union/Russia. The reality has been quite the opposite—an extensive arms race, relative power gains and losses, competition for allies and control of strategic territories between the US and Soviet Union/Russia have gone on unabated. (Charles Wolf, *The Third World in US–Soviet Competition: From Playing Field to Player*, RAND Corporation, 1990, online at https://www.rand.org) This largely occurred at a time when both sides had mindboggling nuclear capacities to wipe out not only each other but the whole planet as well. (John J Mearsheirmer, *The Tragedy of Great Power Politics*, New York: WW Norton, 2001, p231) Moreover, even the conclusive end of the Cold War did not erase the politics of power grabbing between the US and

Russia or even between other nuclear powers such as India and Pakistan. Further, all nuclear powers still envy each other's economic power, military capabilities, conventional superiority, control of geopolitically important territories and access to strategic land, air and sea routes. Nor have they ceased forming alliances or preparing for war.

The contradiction between theoretical expectations and actual practice is the result of an exuberant faith in the survivability of nuclear arsenals. (Thomas C Schelling, *Arms and Influence*, New Haven: Yale University Press, 1966) Enthusiasts argue that even a few weapons strategically deployed could probably survive, thus deterring potential aggressors. Hence, once survival arsenals are deployed, they would most likely dissuade aggressors. Enthusiasts also believe that the survivability of retaliatory arsenals is a "one-way street" and that they accordingly ensure peace, stability and tranquillity between nuclear powers more than any other scenario. The fact however is that retaliatory systems remain vulnerable even after a robust deployment of forces to guard them—there is no hundred per cent security. Moreover, what happens if the survivability is compromised due to technological advancements? Technological breakthroughs are most likely to compel states to circumvent adversarial advances.

Enthusiasts believe that the survivability of retaliatory arsenals is a "one-way street" and that they accordingly ensure peace, stability and tranquillity between nuclear powers more than any other scenario. The fact however is that retaliatory systems remain vulnerable even after a robust deployment of forces to guard them—there is no hundred per cent security.

A PRACTICAL COMPASS

Military planners rely upon three primary designs to secure retaliatory systems and the forces that operate them—hardening, concealment and redundancy. Hardening is a "design or any manufacturing technique" employed to shield retaliatory arsenals, delivery vehicles, command centres and communications systems in the event of an adversarial first nuclear strike. Hardening comprises "robust structural designs, electronic circumvention, electrical filtering and vertical shock mounting". Arguably, it can withstand the effects of nuclear weapons including "the blast, thermal radiation, nuclear radiation, electromagnetic pulse and in some cases, transient radiation effects on electronics". Essentially, it takes three forms—structural, mechanical and electronic/electrical. Structural and mechanical hardening typically involve "robust designs, protective enclosures, protective coatings and proper selection of materials", etc. Electronic/electrical hardening involves "proper components, special protective devices, circumvention circuits and selective shields", etc. Hardening however does have certain disadvantages. While it may be more reliable and relatively safe, hiding hardened weapons is intrinsically difficult and if spotted by the adversary, they remain known, as they cannot be moved elsewhere. More importantly, they may be detected by advanced sensors. Thus, although hardening is a useful and widely preferred design to secure retaliatory systems, it is not the safest design and has been impacted by technological revolutions.

Concealment is the second design to shield retaliatory systems. It is at the heart of survivability as far as mobile delivery systems—ballistic missile nuclear powered submarines (SSBN), mobile missile launchers, etc—are concerned. Concealment may also mitigate some of the disadvantages of hardening, as finding concealed forces, especially mobile ones, is a major challenge. Concealment however is not a perfect design. While it is undoubtedly useful and attractive, it can be destroyed easily. Similarly, concealment makes retaliatory systems susceptible to attack, if the adversary detects and follows them. Technological advancements have also undermined the potency of concealment. For example, during the 1991 Gulf War, US-led coalition forces had struggled to detect Iraqi mobile missiles. Today however, the US with the help of advanced sensing platforms—radars, satellites, drones and ground sensors—can easily detect mobile launch vehicles. Thus, concealment is no longer as reliable as it once was.

Finally, redundancy is also a potent design for guarding retaliatory systems. This implies the presence of "extra components in a system or piece of equipment or the provision of alternate methods to accomplish a function—if one fails, another is available". (US Government, *Nuclear Matters Handbook*, 2016, p228, online at http://www.acq.osd.mil) However, this increases the complexity of a system and production costs. For example, redundancy requires extra production quantity and lengthens operations. States erect multiple delivery systems to mislead enemy forces and mitigate unexpected design flaws. Additionally, redundancy also means spreading across multiple-based warheads, launch pads, delivery platforms, communications networks, command and control arrangements and early warning systems. All this is done to ensure that if one fails, another is available. However, technological trends have also adversely affected redundancy as much as other designs.

Hence, no design is perfect or ideal and states usually embrace a combination of all the designs discussed above. Technological advancements however have eroded the foundations of survivability. Advances in accuracy undermine the survival of hardened arsenals while those in remote sensing reveal concealed forces and the strategy of redundancy has been challenged by smaller arsenals. This does not mean that survivability has become impossible, rather new technological trends suggest the beginning of a new age of "counterforce". The following section delves into technological trends eroding survival strategies.

THE TECHNOLOGY: CHANGING CONTOURS

As pointed out above, technological trends are the most significant variables eroding the survivability of retaliatory arsenals. This paper now looks at the condition of nuclear deterrence during the peak of nuclear development. Even during the zenith of the nuclear age, delivery vehicles like bombers and ballistic missiles were not very reliable and several variables affected aircraft-borne bombs such as atmospheric conditions, temperature, humidity, the aircraft's speed, altitude, etc. Hardened arsenals therefore had greater survivability. Similarly, missile-borne nuclear payloads were not very accurate in destroying hardened arsenals. Changing technological contours however have significantly improved accuracy in delivery. The new onboard computer-assisted navigation and guidance systems now aim at a target and continuously measure variables that affect delivery. Consequently, hardening, concealment and redundancy have become more intricate, if not entirely unreliable.

Advances in accuracy undermine the survival of hardened arsenals while those in remote sensing reveal concealed forces and the strategy of redundancy has been challenged by smaller arsenals. This does not mean that survivability has become impossible, rather new technological trends suggest the beginning of a new age of "counterforce".

The Alchemy of "Accuracy"

Accuracy has made ballistic missiles more potent. (Michael Russell Rip and James M Hasik, *The Precision Revolution: GPS and the Future of Aerial Warfare*, Annapolis: Naval Institute Press, 2002, p63 and p66) While earlier they were considered useful to destroy soft targets like city centres, now they have been turned into potent instruments for destroying hardened targets as well, due to onboard computer navigated, measured and managed accuracy. (Daniel H Platus, "Ballistic Re-entry Vehicle Flight Dynamics", *Journal of Guidance Control and Dynamics*, vol5, no1, 1982, p6) Moreover, improved accuracy has enabled submarine-borne ballistic missiles to move from one point to another without being detected and strike targets with razor sharp precision. The potency of missiles has also increased due to advanced fuses. (Hans M Kristensen and Robert S Norris, "United States Nuclear Forces 2016", *Bulletin of the Atomic Scientists*, vol72, no2, 2016, p64, p66 and p68) The new fuse systems, unlike their older counterparts, use an altimeter to calculate the difference between the actual and expected trajectory of re-entry vehicles and then compensate for inaccuracies by adjusting the warhead's height of burst (John Stillion and David T Orletsky, *Airbase Vulnerability to Conventional Cruise Missile and Ballistic Missile*, RAND Corporation 1999, online at https://www.rand.org). An altimeter is a device for determining the altitude of an object above a fixed level. American submarine-launched ballistic missiles will soon have altimeters known as "compensating" fuses. These are highly effective as they reveal whether the warhead is off track or short of the target and take the warhead closer to the target. (William Z Lemnios and Alan A Grometstein, "Overview of Lincoln Laboratory Ballistic Missile Defence Programme", *Lincoln Laboratory Journal*, vol13, no1, 2002, pp9–31) Compensating fuses will soon be available to all states with modern multistage ballistic missile systems, as building altimeter fuses is not difficult. Ballistic missiles with new compensating fuses will be fully capable of hitting hardened or concealed arsenals. Broadly speaking, ballistic missile launches will soon be revolutionised due to highly effective high-tech devices such as fuses. This is yet another example of a variable jeopardising the survivability of retaliatory arsenals.

The improvement in accuracy has brought within the ambit of possibility "rapid missile retargeting". This multiplies the potency of ballistic missiles by reducing malfunctions and reintegrates communication and weapon systems into a single console. However, increased missile accuracy may reduce missile reliability as far as hardened targets are concerned. The solution is that if missile failures are detected, targets can be reassigned to other missiles held in reserve. (John D Steinbruner and Thomas M Garwin, "Strategic Vulnerability: The Balance between Prudence and Paranoia", ernational Security, vol1, no1, 1976, pp151–5 and pp159–68) Rapid missile retargeting is now ossible due to modern technologies including accuracy measuring devices. The ccuracy is of such magnitude that retargeted missiles can hit targets in a matter of minutes. According to media reports, the US installed rapid retargeting missiles on its intercontinental ballistic missile launch control centres in the 1990s (Amy F Woolf, *US Strategic Nuclear Forces: Background Development and Issues*, Washington DC: Congressional Research Service, 2016) Other nuclear powers might have also already developed and incorporated rapid retargeting capability given their proven ability to match technological breakthroughs. Thus, the age of accuracy has enabled nuclear weapon states to develop and incorporate newer technological breakthroughs that considerably erode the survivability of retaliatory arsenals.

Of greater note is the fact that the accuracy revolution is ongoing. (Jeffery S Nighbert, *The Accuracy and Precision Revolution: What's Ahead of GIS*, 2010, online at http://www.esri.com) This means that improved accuracy will probably keep sharpening the effectiveness of conventional weapons, which can then be used to target hardened arsenals. This is indeed a worrisome scenario for all nuclear states and will probably shape the future of not only nuclear deterrence but also nuclear warheads, delivery systems and the forces raised to handle them. While this will take time (a few more decades), what is deeply disconcerting is the rapid development of robots and artificial intelligence and the discourse that they could take over hundreds of thousands of human jobs worldwide in just another decade or two—the impact on warfare, including nuclear war, will be huge.

Modern data gathering sensors of remote piloted crafts can loiter near enemy targets and monitor critical road junctures for months or years on end. Modern sensors are capable of gathering, storing and transmitting data much faster, enabling handlers to observe persistently the movement of enemy arsenals.

The Shine of "Remote-Sensors"

Advances in remote sensing have reduced the viability of "concealment" as a strategy of shielding nuclear forces. (Alan J Vik, Richard M Moore, Bruce R Pirnie and John Stillion, *Aerospace Operations against Elusive Ground Targets*, RAND Corporation, 2001, online at https://www.rand.org) Ballistic missile submarines, mobile land-based missiles and the forces trying to track them have made the task of "hiders" far more difficult, if not entirely impossible. The specific trends that have revolutionised the pattern of seeking concealed arsenals include diverse sensor platforms, numerous techniques of analysing sensor signals, persistent observations made possible by signal intelligence antennae, undersea hydrophones and geostationary satellites, satellite image resolution and data transmission speed. (Defence Advanced Research Projects Agency, *Breakthrough Technologies for National Security*, 2015, online at https://www.darpa.mil)

The first sensor propelled trend making the task of "seekers" easier and the job of "hiders" more difficult is the diverse sensor platform. During the Cold War, the intelligence on the whereabouts of enemy arsenals was tracked by not-so-advanced satellites, submarines and piloted aircraft. While many of these instruments are still in use, they have been supplemented by new platforms. Today intelligence gathering on enemy arsenal movement is done by remote piloted aircraft and underwater drones. Enemy facilities, forces and operations are under the constant watch of underground and undersea hidden sensors. (*ibid*) Thus, nuclear states have multiple platforms to monitor the movement of enemy arsenals and such a close, constant and up-to-date monitoring has been made possible by advanced sensor technology.

The second sensor propelled trend is the new and multiple signal analysing technique. (Institute of Nuclear Materials Management, *Information Analysis Technologies, Techniques and Methods for Safeguards, Nonprolifertion and Arms Control Verification Workshop*, 2014, online at http://www.inmm.org) During the Cold War, both peace and war time intelligence gathering of enemy arsenals was done by photoreconnaissance, underwater acoustics and adversary telecommunications. These techniques are still in use as well, but modern techniques now gather data from the entire electromagnetic field. Highly effective techniques that have fast become prominent include spectroscopy to identify vapours leaking from faraway facilities, interferometry to discover underground structures and signal processing techniques such as underpinning synthetic aperture radars to perform better. Modern sensors now have the ability to emit radar waves at various frequencies to maximise resolution and penetrate foliage. In other words, nuclear states now gather far more accurate intelligence about enemy movement using advanced sensors.

The third sensor propelled trend is persistent observation made possible by signal antennae, undersea hydrophones and geostationary satellites. During the Cold War, strategic intelligence was done by sensors that collected snapshots and not streams of data. Spy planes and satellites sprinted past targets, passed overhead and then disappeared over the horizon. These days, alongside the old sensors, new platforms soak up data transmitted by intelligence antennae, undersea hydrophones and geostationary satellites. In addition, modern data gathering sensors of remote piloted crafts can loiter near enemy targets and monitor critical road junctures for months or years on end. Modern sensors are thus capable of gathering, storing and transmitting data much faster, enabling handlers to observe persistently the movement of enemy arsenals.

The fourth sensor propelled trend is the improvement in satellite image resolution. (Rodolfo Quevenco, "Completing the Picture: Using Satellite Imagery to Enhance International Atomic Energy Agency Safeguards Capabilities", *International Atomic Energy Agency Bulletin*, 2016, online at https://www.iaea.org) Earlier, remote sensing technology used to be weak with poor resolution leaving scientists unable to make sense of the imagery. Modern sensors and new data processing devices enable the scientific community to measure accurately the contents transmitted of even the faintest image and lowest background sound. For example, while older reconnaissance satellites could detect objects as small as 25 feet across, modern reconnaissance satellites such as WorldView-3 and WorldView-4 can collect images with one-foot resolution. American spy satellites are alleged to be capable of resolutions less than four inches. Modern sensors thus enable nuclear states to not only collect strategic intelligence about enemy arsenals, their movements and other related facilities from upclose but also allow them to know the exact status of enemy retaliatory systems. Infrared sensors, advanced radars, interferometers and spectrographs have thus transformed the very nature and type of strategic intelligence.

The US is said to have developed a missile defence system that can detect incoming missiles and destroy them mid-air, well before reaching the intended targets. This system (THAAD) is built around the technological expertise of the American surveillance establishment and is said to have been deployed recently in South Korea to mitigate possible missile-borne threats from North Korea.

The fifth sensor propelled trend is the speed of data transmission. (World Institute for Nuclear Security, *Data Analytics for Nuclear Security*, 2015, online at https://www.wins.org) During the Cold War, transferring information from unit A to unit B took days, as did data processing involving satellite photos. The older satellites were also much slower. Strategic intelligence with imagery had to be flown to a suitable facility for analysis and analysts took time reaching a definitive conclusion. Today, things are quicker and very different—aircraft, drones, satellites, etc collect the intelligence, which is quickly transmitted to a suitable centre. The processed intelligence then reaches the table of decision makers. A decision then taken is sent for implementation and all this happens within a matter of minutes or at the most hours, depending upon the nature of the content. Modern sensors have thus increased data processing speed a million times over and reduced the time consumed from days to hours or even minutes. In sum, the shine of sensors or the sensing revolution, as it is called, has significantly improved the ability of military planners to track enemy arsenals. This is a global phenomenon and no nuclear state is immune from its impact. Some countries have been more successful in hiding their arsenals than others. While the US has exploited the new sensing technology to great effect, others are fast catching up.

The Shrinking Circle of "Roaming"

The circle of "roam-free" arsenals is shrinking fast and the strategy of securing nuclear arsenals through "redundancy" is also under duress. During the Cold War, both primary and extra or alternative arsenals roamed free without being detected. Secrecy was the cover under which alternative arsenals were made secure, sound and safe and as such could be relied upon. Technological advances however have reduced the degree of reliability considerably. For example, the US could locate, count and track Soviet SSBNs for long spells of time—days, months and even years. It could do so because of technological breakthroughs like hydrophones and super-computers—underwater hydrophones identify and locate enemy arsenals while computers process the generated data. By the 1970s, the US had equipped itself with advanced sonar, sonar arrays and on-ship computing facilities, which receive, hold and process data in real time. As soon as the Soviets realised that their arsenals, particularly mobile ones, had been revealed and were being followed by the US, they too acquired similar capabilities. The major nuclear powers—China, France Russia, the UK and the US—constantly seek newer competitive technological prowess, undermining the survivability of nuclear weapons, especially mobile arsenals. As a result, alternative arsenals too have stopped roaming freely.

Improved technological competence also frustrates attempts to secure nuclear mobile missiles. Ultra-advanced surveillance systems such as radar satellites and remote piloted aircraft enable nuclear countries to track enemy arsenals, particularly mobile missiles capable of carrying nuclear warheads. While the effectiveness of surveillance systems depends upon the traits of the object being tracked—size, location, topography and protective features—the surveillance systems of countries leading in technological advancements (China, Russia and the US) have adapted to the new challenges. The US is said to have developed a missile defence system that can detect incoming missiles and destroy them mid-air, well before reaching the intended targets. This system (THAAD) is built around the technological expertise of the American surveillance establishment and is said to have been deployed recently in South Korea to mitigate possible missile-borne threats from North Korea. Moreover, the US has been reportedly tracking China's mobile missiles for years while the Chinese, using modern technology have considerably reduced the risk to their nuclear capable missiles. Likewise, India and Pakistan, the arch Asian rivals, have been chasing the movement of one another's nuclear arsenals as well. In this battle, India has been using its newly acquired satellite launch capabilities, whereas Pakistan has been actively assisted by China. Thus, improved technology has made the sport of "hide and seek" even more complex.

China's nuclear-armed submarines are noisier than their American or Russian counterparts and therefore more susceptible to detection. Nevertheless, the Chinese are yet to develop suitable technological measures to mitigate this challenge. India and Pakistan too have been struggling to develop appropriate measures to increase the survivability of their nuclear arsenals.

THE NEW RACE

In the context of the changing technological contours discussed so far, it is clear that nuclear powers will increase their endeavours to shield retaliatory arsenals and the forces that organise them. However, the greater the efforts to secure arsenals, greater will be the efforts to overcome them. This vicious cycle could potentially engender a new arms race—the signs of which are already discernible.

First, the greater the resources, the greater the benefits, in other words, the countries that possess more, will gain more. Thus those that command better technologies and have the institutional ability to harness them to the optimum will secure retaliatory arsenals and the forces that organise them more effectively than those that command less. For example, American retaliatory systems are far more secure than those of China, France or the UK, as the US is the leader in technological revolutions from aeronautics to astronomy to astrophysics. The rest merely follow in its footsteps, albeit with some tweaking here and there to satisfy nationalist egos. It is well known that the latest trends in technology largely stem from the US, more so in the military field. Although China, Germany, India, Japan and Russia are indeed riding technology revolutions, they lack comparable human, institutional and material capacities needed to prop up technological prowess. In the domain of the safety of nuclear weapons and the forces that guard them, there is no doubt that nuclear arsenals are more vulnerable today than before and concerned countries have increased efforts to shield them. However, as increased security steps incentivise peers to follow suit, ultimately all are left even more vulnerable. This is a sure recipe for a furious and ceaseless arms race.

Second, the retaliatory forces of all nuclear countries are in a peculiar bind, as they require the capability to attack not one but multiple enemy warheads simultaneously. As noted above, nuclear countries use a combination of strategies to secure retaliatory forces. This means that they have to raise, maintain and guard an array of retaliatory platforms—attack aircraft, missiles and submarines—spread across all potential conflict arenas. On the one hand, they have to hide from enemy eyes and on the other know the whereabouts of their enemies' retaliatory platforms and know them well—exact numbers, facilities and types. In other words, nuclear countries have to keep making technological breakthroughs to face multiple adversarial warheads while reliable retaliatory forces must be able to knockout an "array" of weapons. Nonetheless, the fact remains that all countries are progressing down the same path—gaining the ability to hit multiple warheads simultaneously. Hence, as one country surmounts an enemy's perceived technological breakthroughs, the adversary in turn does the same and this continues unabated leading to an arms race.

Finally, certain scenarii will be difficult to overcome. For example, the Soviet Union during the Cold War discovered that American intelligence was tracking the movements of its SSBNs, yet it could not do much in the short term. Eventually however it managed to develop the technological ability to counter it. China is currently facing a similar challenge. Its nuclear-armed submarines are noisier than their American or Russian counterparts and therefore more susceptible to detection. Nevertheless, the Chinese are yet to develop suitable technological measures to mitigate this challenge. India and Pakistan too have been struggling to develop appropriate measures to increase the survivability of their nuclear arsenals. Thus, survival capability is not evenly distributed among all nuclear countries and it will take time to resolve certain challenges. However as technologies and techniques advance, new challenges will be engendered and nuclear countries will work harder to face them. In short, the race for technological breakthroughs will continue as no nuclear power can afford to be complacent. However, as some will be more successful than others, this will act as the "fuel" to fire a new arms race. In fact, technological breakthroughs and advancements have often been the most important variables affecting not only nation-states but human lives as well. While the battle lines may be drawn, the outcomes will depend on the contexts—economic, military, political and technological—under which the battles rage.

India and Pakistan desire to keep the doors open to further probable inductions into their nuclear postures. This is to surpass possible technological advancements from the other side and keep the option of upgrading arsenals and the forces that support them. The result is nothing but a new arms race, which is already well underway.

A CASE SCENARIO: INDIA AND PAKISTAN

In South Asia, the policy implications of ceaseless technological advancements will be palpable, pervasive and profound. Both India and Pakistan will probably find themselves in a policy bind, as their chosen path is one of following each other in technological breakthroughs in the name of national security or defence. Their nuclear postures have several interesting aspects and the most relevant ones are examined below.

First, while India's nuclear posture is of "minimum credible deterrence", (Press Information Bureau, *India's Nuclear Doctrine*, 2003, online at http://pib.nic.in) Pakistan's is of an ultimate weapon against an "existential threat" from outside. (Pakistan Defense, *Pakistan's Nuclear Doctrine*, June 2009, online at https://defence.pk) A minimum credible deterrence however will be neither minimal nor credible and will probably unfold as follows. If the deterrence is expected to be credible, it will probably not accept any minimal standard that adversely affects credibility. Conversely, if minimal is a guiding variable, credibility will not be the final outcome. This means that the Indian nuclear posture is self-contradictory. Nevertheless, it is a purposeful contradiction. On the one hand, India may argue that its nuclear programme is defensive, as it talks of minimal as a constraining variable. On the other, it may set aside any potential constraints that even remotely diminish its retaliatory credibility. Pakistan's posture is no better in its clarity. The use of an ultimate weapon against an "existential threat" from abroad allows Islamabad all possible leeway to enhance its retaliatory systems. In addition, an existential threat is purposely left undefined. This makes abundantly plain the desire of both sides to keep the doors open to further probable inductions into their nuclear postures. This is to surpass possible technological advancements from the other side and keep the option of upgrading arsenals and the forces that support them. The result is nothing but a new arms race, which is already well underway.

Second, India stipulates to "no first use", ("Government unlikely to Change its No First Use Nuke Policy", *The Hindu*, 2017, online at http://www.thehindu.com) whereas Pakistan has no such constraint. ("How Pakistan is Planning to Fight a Nuclear War", *The National Interest*, 2017, online at http://nationalinterest.org) India has consistently maintained (so far at least) that it will not use nuclear weapons against non-nuclear states nor will it use them as the first weapons of choice against nuclear states. The implied suggestion is that India will not threaten any state whether nuclear or non-nuclear with nuclear weapons, nor will it use them except in self-defence. While this may sound fantastic, it is not straightforward, as India may not feel it necessary to restrict the number and type of its arsenals necessary for self-defence. That is, it may use the term self-defence in its own interests. Pakistan has no constraints of no first use or no use. It has kept the possibility of using its nuclear arsenal wide open. This perhaps is the result of its relatively moderate conventional combat capability vis-à-vis India. This is also related to technology induced scenarii of the future and a desire to keep nuclear deterrence as an option.

Third, although Pakistan has reportedly also developed "tactical nukes", ("The Dangers of Pakistan's Tactical Nuclear Weapons", *The Diplomat*, 2017, online at http://thediplomat.com) India has never publicly articulated a response. Tactical nuclear weapons are designed to be used on battlefields in military situations. These come in different forms—artillery shells, depth charges, gravity bombs, landmines, short range missiles, torpedoes, etc—and would be effective in demolishing enemy "chock-points" such as long viaducts, narrow mountain passes and tunnels. (Institute for Defence Studies and Analysis, *Pakistan's Tactical Nuclear Warheads and India's Nuclear Doctrine*, 2016, online at http://idsa.in) Pakistan's primary reason for developing tactical nukes is India's technological forward movement. Through these weapons, Islamabad hopes to circumvent possible technological breakthroughs by India. On New Delhi's part, there appears to be no articulated response to these nuclear weapons. However, there is no dearth of options available to mitigate such threats to military facilities, storage sites, units, etc. Moreover, given the robust, sizable and advanced institutional base, it will not be difficult for India to neutralise any hostile nukes. It will merely develop its own tactical nuclear weapons, which may be even more advanced than Pakistan's. Hence, India and Pakistan are both concerned about technological breakthroughs on the other side and their cascading effects on nuclear arsenals and retaliatory forces.

CONCLUSION

Compared to the Cold War era, modern nuclear arsenals and the systems that operate them have shrunk in size, surged in stealthiness and increased in accuracy on account of technological revolutions. As a result, retaliatory arsenals, forces and other auxiliary subsystems have become more vulnerable. Survival strategies such as "hardening", "concealment" and "redundancy" are no longer robust, as most nuclear countries now have the technology to trace, track and crack enemy arsenals. Accordingly, these countries are doing their utmost to improve retaliatory capacities by developing technologies that are even more advanced. However, this has made nuclear arsenals more insecure and fuelled a new arms race among the nuclear elite.. The new technological contest is a serious challenge to the entire retaliatory system—the heart and soul of nuclear deterrence.