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THE DEBATE ON EMERGING TECHNOLOGIES: SOME REFLECTIONS

by

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This paper has been prepared for the BDM Corporation and is largely based on the discussion at the Conference on "Emerging Technologies for Deterrence and Defence" held in Rome on November 19-20, 1987 and co-sponsored by the BDM Corporation, the Istituto Affari Internazionali and the Center for Higher Defence Studies of Rome.

This paper intends to highlight some of the most relevant issues concerning Emerging Technologies (ET) as they were discussed at a Conference on "Emerging Technologies and the Economics of Defence" held in Rome on November 19-20, 1987 and co-sponsored by the BDM Corporation, the Istituto Affari Internazionali and the Center for Higher Defence Studies of the Italian Armed Forces. As such, it does not purport to provide an exhaustive survey of the intricate technological, military, economic and political issues involved in the subject. More modestly, it will emphasize what seemed to this writer to be the most useful indications which emerged from that meeting and then point to a few others which perhaps did not receive as much attention as they deserve. For brevity, I will avoid to repeat here what has been dealt with in other papers.

Though for the sake of simplicity I will not attribute any statement of opinion or of fact to any conference participants, I wish to acknowledge that many of them provided insightful contributions to the discussion at the conference itself and hence to this paper. All of this paper remains of course my own responsibility.

1. Emerging Technologies: Defining the Issues

The first problem that is encountered in discussing ET is to define the term. In the last few years, as the debate about ET has gained prominence in NATO, the term has acquired different meanings in different contexts. Thus, ET include a spectrum of technologies which range from some which are already operational, or almost so--though perhaps not yet fielded in actual systems--to others not yet ready though at an advanced developmental stage. It was recognized at the conference that it is often difficult to draw precise boundaries among the categories above. Therefore, some ambiguity in the definition of ET, and hence in the debate around them, is unavoidable.

The vast and heterogeneous debate over the technologies related to the Strategic Defence Initiative (SDI) of the United States has perhaps

contributed to compound confusion. One should remember that "emerging", in the context of ET, signifies technologies which will be operational in 5 to 15 years. The spectrum of technologies considered for SDI, instead, has spanned to other more esoteric technologies which are still at an early experimental stage and thus not yet "emerging". Such confusion has to some extent carried over to the Soviet Union as well--see below.

In turn, virtually all areas of advanced technological research contribute, more or less directly, to ET. Specialists in information processing hardware and software, materials science, biotechnology, several branches of engineering, etc. are all involved in developing basic technologies of potential military interest.

As for the types of possible operational applications, here too ET span across a wide variety of highly differentiated potential uses: sensors, projectiles, launch platforms, warning systems, communication, target acquisition, armor, etc. can all benefit from the contribution of ET. Hence the emphasis which several participants placed upon the dual purpose of ET: strengthening deterrence as well as providing for more powerful defence capabilities.

The two missions of deterrence and defence, of course, overlap to some extent, but are nonetheless quite different. Purely war-fighting ET, such as homing guidance systems or reactive armor, might of course contribute to the so-called "deterrence by denial"; however, they are primarily intended to fight a war should deterrence fail. On the other hand, other types of ET, such as communication techologies or use-control devices, are more directly intended to strengthen deterrence, though they too would enhance war-fighting capabilities.

This differentiation might at first appear a rather abstract and academic one, but it becomes very concrete when alternatives must be evaluated in the context of a coherent strategy with limited resources available to be spent on very expensive hardware and software. In this context, it is regrettable that there is a widespread tendency to emphasize the "defence"-oriented categories of ET over the "deterrence"-oriented ones. As section 5. in this paper will point out, there are other, more purely "deterrent" missions for ET which deserve as much attention.

2. Emerging Technologies and Conventional Forces

ET are often dealt with as simply an alternative to more robust traditional conventional forces. Much in the same way that nuclear weapons were seen in the 1950s as a "technological fix" to seemingly unsurmontable conventional force problems, ET in the 1980s are often presented as a technological solution to provide a qualitative answer to essentially quantitative problems of conventional force levels and expenditures.

As it turned out, nuclear weapons did not provide the technological fix for perceived conventional inadequacies in the fifties: the initial optimistic assessment of their substitutability for conventional forces proved erroneous, despite the fact that the capabilities and effects of nuclear weapons were relatively well understood. There is no evidence that current assessment about the substitutability of ET for conventional forces will fare any better in the '80s. Hence, assumptions to this effect are unwarranted, might be illusory, and should therefore be avoided, for at least three reasons.

First, large uncertainties still surround the potential capabilities of ET. Moreover, these capabilities, in light of the highly diversified

nature of the technologies involved, are certain to be quite uneven. Therefore, at this time, it would be hazardous to count on them to fill any perceived gap in conventional force requirements which, on the contrary, can be defined and quantified with relative precision.

Second, progress in ET development and deployment will be evolutionary rather than revolutionary, and the pace of this progress rather unpredictable. As with all new technologies, many of them will take long years to test and perfect until their performance and reliability will achieve acceptable levels. Therefore, it would be unwise to rely on them to solve immediate problems which require short-term solutions.

Third, ET will also be developed by potential opponents, both to emulate and to ready countermeasures to our own ET. The West clearly enjoys an advantage of at least several years in advanced technologies in general and, to a first approximation, in ET as well--though the inevitable secrecy and inherent uncertainties make it impossible to arrive at a more precise assessment of this advantage on an unclassified basis. However, it is well known that the West has had a particularly disappointing propensity to underestimate the time needed by the Soviets to "catch up" on new technological breakthroughs, beginning with the nuclear bomb.

Finally, the operational applications of each ET deserves further study. The capabilities of what will be procured need to match what is needed to deter and defeat likely Soviet offensive operations. Yet, to deduce the latter from available intelligence leaves rather large margins of uncertainty. For example, one participant questioned the wisdom of concentrating our efforts on the development of ET for Deep Attack--intended mainly at disrupting Soviet second echelon forces and re-supply lines--while the Soviets seem to be placing increasing emphasis on light maneuver groups which would be less dependent on the very reinforcement NATO's ET would be designed to disrupt.

These points do not necessarily argue that therefore ET, as they are defined today, are useless and should not be pursued. In fact, quite the opposite conclusion might be drawn from them: in light of unavoidable uncertainties and of similar Soviet efforts, ET should be pushed with increased vigor. In the next few paragraphs I will outline a set of reasons why in fact ET would play a useful role for NATO security. The issue is far from settled. But it is important to underline that, in any case, ET should be researched, developed, deployed or negotiated away for their own merits, and not in connection with the conventional balance of forces in Europe.

3. The Case for ET in NATO

There are at least five reasons to pursue ET which one might categorize as continuing factors of the NATO overall posture development. The following paragraphs will outline each in turn.

First, NATO is placing ever less emphasis on nuclear deterrence and defence in favor of a more conventionally-oriented posture. The US has consistently moved in this direction ever since the McNamara speeches at Athens and Ann Arbor in 1962; also the Soviets have followed suit, if somewhat belatedly, providing further incentive for the West to persist; and, finally, Western European publics--if not national security elites--have become steadily more uneasy with nuclear weapons altogether.

Irrespective of what one might think of this trend, which many Europeans still do not like, it can not be discounted, nor can it be reversed in the immediate future. In fact, unless Western Europe takes on a

substantially increased nuclear responsibility to maintain a nuclear-based deterrent--which is not likely to happen soon--NATO's posture is heading for a slow but surely thorough conventionalization. This trend is not new and it is not surprising, since it serves an obvious and permanent US interest in limiting the damage to itself of a possible European war. ET might help to strengthen deterrence in this transition to a less-nuclear posture.

Second, some ET, such as for instance homing devices, terminal guidance systems and sophisticated sub-munitions, are needed to implement the deep-strike capabilities that all NATO allies have agreed to procure to strike Warsaw Treaty Organization (WTO) forces in the rear. They might be particularly useful in light of the Soviet trend to reduce concentration of troops and thus diminish the attractiveness of their offensive forces for NATO nuclear strikes. ET might help NATO strike in a more discriminate fashion which would be better suited for larger numbers of individually less lucrative targets.

Third, some argue that ET are needed to provide better conventional war-fighting efficiency in light of the upcoming and unavoidable demographic problems of NATO, even if there seems to have developed a consensus among experts that they probably can not fully make up for manpower deficiencies.

Fourth, one intrinsic, though indirect, merit of ET is that, because the involved R&D is time-consuming, expensive and technologically very challenging, they would force military as well as political and budgetary authorities to longer-term planning, and thus might help defeat some of the cyclical oscillations which some Western defence budgets suffer from.

Finally, for the same reasons pointed out in the preceding paragraph, ET are likely to encourage and reward international inter-allied cooperation, particularly because many of the efforts required are too demanding for many individual allied countries to undertake alone. Yet, any advanced technology, and military ET are no exception, represents the result of an effort in terms of capital by its developer, who is therefore unlikely to give it away in exchange for nothing. That ET should be developed according to one's capabilities and distributed according to one's needs might be theoretically sound from the overall point of view of alliance resource optimization, but it is a utopia and can not be a sound basis for a long term strategy.

Therefore, for an effective network of interallied cooperation to develop military high technology, it will be necessary for all to undertake their share of the common effort. In the realm of defence economics, too little has been achieved so far for the attainment of satisfactory economies of scale. One problem here is that many individual Western European industries are too small to be competitive. The creation of consortia would be essential to make them technologically viable and economically sound; this is in part already being done, and should continue to receive the active political support it deserves.

The preceding paragraphs have outlined several reasons why NATO shold continue to devote attention to ET development. However, I do not intend to suggest that we should engage the Soviets in a new arms race on emerging technologies. In fact, while research and laboratory experimentation should in all cases be allowed to proceed--if for no other reason as a hedge against unforeseen cirsumstances in the future--arms control agreements to regulate the testing and deployment of potentially destabilizing ET should be explored and pursued. It must be recognized that ET would be a particularly difficult object for arms control negotiations, first of all

for the inherent imponderability of the matter. Yet, in the context of future conventional arms control negotiations, it should not be impossible to devise adequate verification procedures to make a mutual regulation of ET deployments a feasible means to increase stability.

4. Some Open Questions about Emerging Technologies

The most important question about each ET, as should indeed be the case for all military technologies, is to define in as much detail as possible what missions it is designed to accomplish. Clearly, it will not always be possible to specify the precise applications of new technologies at an early stage in the R&D process, but this should be done once plans for operational applications and procurement begin to be drawn.

In other words, ET operationalization should be an exercise in "requirement-pull", and not in "technology-push". Often in the past new technologies have been incorporated into new weapon systems not because there was a clear military requirement for them, but simply because they were available.

On rare occasions, technology-pushed innovations have yielded a net benefit by providing the armed forces with technical instruments that they had not thought of asking the laboratories to develop but which they later nonetheless found useful. Such was the case, for instance, with the development of the Permissive Action Links (PALs), conceived by the engineers of US nuclear laboratories and then introduced into parts of the US nuclear arsenal. Most military commanders today would agree that such devices provide a good insurance against the danger of unauthorized and inadvertent nuclear detonations. PALs are a perfect, if rare, example of a technology-pushed ET which serves the interest of strategic stability and thus the security of the West.

Unfortunately, many other technology-pushed innovations in weapon capabilities, such as the development of ballistic missiles, MIRVing technology, accurate guidance systems, and many others worked in the opposite direction, increasing instability. For this reason, it would be unwise to rely on the creativity of scientists to reshape the technological requirement of the military: it shold remain up to the latter to direct the efforts of the scientific community in the direction required to satisfy the security needs of the West.

To define requirements which ET are expected to satisfy as clearly as possible should then be the first task which confronts planners. Having done that, ET will have to be evaluated on their own individual merits against possible alternatives. The two fundamental criteria against which procurement decisions should be founded are first, the contribution of a particular ET application to strategic and crisis stability, and second, its cost-effectiveness.

As for the former, ET will provide a useful contribution to Western security if they will help the defence against possible decisive advantages of the offence, particularly in case of a surprise attack. Thus, for example, advanced anti-tank technologies will buy insurance against one of the most feared capabilities of the Warsaw Pact while not constituting a provocative offensive threat in themselves.

As for the second criterion--cost-effectiveness--there should be no illusions that the costs of ET will be high. Yet, ET might prove a worthwhile investment if significantly cost-effective against prospective Soviet off-setting technologies--how "significant" such cost-effectiveness

would have to be depends of course not only on the costs of opposing weapon systems but also on the total amount of resources that each side would be able to dedicate to their procurement. One such case seems to be that of advanced anti-tank technologies, which might make the cost of an effective anti-tank weapon at least one order of magnitude cheaper than a tank itself, thus making the cost-exchange ratio undoubtedly favorable for the defence.

The above paragraphs might seem rather vague and abstract. Perhaps they are, and unavoidably so. In fact, it is not the purpose of this paper to exhaust the issue of the advisability of ET, nor would it be useful to repeat what has been dealt with in greater detail in other papers at the conference. I have simply intended to reiterate the two basic criteria against which their evaluation should be made--stability and cost-effectiveness. Uncertainties are still large on both counts, not least because it is difficult to predict how the Soviets would react to our initiatives. Needless to say, further close study on both issues should continue to receive high priority.

5. A Neglected Perpective on ET

The preceding pages have dealt with ET principally from the point of view of their potential contributions to the battlefield war-fighting potential. While this is certainly the focus of most analyses today, there are other types of ET, not directly related to fighting operations, which nonetheless deserve as much attention because of their possible contribution to the strengthening of the alliance's deterrent. In other words, next to the issue of "ET for defence", there is something to be said for "ET for deterrence". The two clearly overlap to an extent--the argument being that good defence provide "deterrence by denial"--but are nonetheless not the same.

The other type of deterrence--deterrence "by punishment"--is the fundamental pillar upon which most Europeans still insist their security must be maintained. Deterrence by punishment requires that nuclear forces satisfy as best they can the so-called "always-never mission", meaning that their retaliatory potential must never be launched except in response to deliberate attack, but an opponent must be made certain--and thus deterred--that it will always be launched in such a case. In order to satisfy this requirement, several areas of advanced technologies can be utilized. This section will briefly outline a few possible such areas.

. The first area where ET might contribute to a more stable deterrent, without bolstering potentially provocative war-fighting capabilities, is that of crisis-management. In particular, advanced electronic information processing technologies should be applied--by the West and the East alike--to provide decision-makers with real time information which might help prevent rush decisions and thus diffuse crises. Much is doubtless being done on this score, and detailed assessment would have to be done at a classified level. However, the past teaches us that several crises might have been diffused had available technology been dedicated to crisis management. For example, there was no "hot-line" at the time of the Cuban missile crisis, though all relevant technology was readily available and the requirement for a direct link between the superpowers' leaders should have been all but apparent beforehand.

Early warning is another example where advanced radar and sensor technologies can and should help to provide for a robust and maximally

reliable apparatus to prevent accidental war and reduce incentives for pre-emptive strikes.

Third, nuclear weapon safety and security should continue to receive a high degree of attention. Much has been done by the US and NATO in this respect, but the potential costs of a breach of nuclear weapon security are so high that relevant procedures and devices should continue to receive careful attention. In this context, it would perhaps be advisable to reconsider placing remotely controlled in-flight self-destruct mechanisms in nuclear delivery vehicles, as a hedge against accidental launches. This option was considered in the past and rejected on grounds of the unreliability which such devices would introduce into the weapons and also because relevant information--such as self-destruct codes--might fall into enemy hands and enable him to neutralize our deterrent forces. Today's high data-rate transmission and information processing and encryption techniques might provide a basis for renewed attention to this problem.

Fourth, ET can play a role in improving communication capabilities, particularly in areas where they are still woefully deficient, such as with submarine communication. The latter is the single most serious draw-back of the most important leg of the US strategic triad. There seems to be a substantial chance to redress this problem through blue-green lasers in the not too distant future, and all possible avenues should be pursued to this end. If still relatively invulnerable submarines could receive and transmit information and orders while submerged, a great step would have been accomplished toward a more stable strategic environment.

Finally, as one participant pointed out, ET should provide an opportunity to reshape not only the hardware in the field, but also the thinking that underpins its operations. Intentions are at least as important as capabilities, and the introduction of new technologies should be an opportunity to develop more mutually reassuring doctrinal assumptions. This of course, depends to a large extent on what the Soviets will do in this respect.

According to one participant who has followed Soviet writings on ET, there has developed a debate in the USSR in the 1980s about what the desirable role of ET should be. This debate has to some extent been spurred by Western challenges, and in particular by SDI. The Soviets, much like many observers in the West, apparently draw but a blurred distinction between ET and more experimental and esoteric technologies such as most of those which fall under the SDI cover. The debate in the USSR has also taken the form of a civil-military dispute, with at least some of the military--including former Chief of the General Staff Ogarkov--pushing for an immediate Soviet emulative response to Western efforts in ET. Others, who in the end prevailed with the accession to power of Gorbachev, argued on the contrary that priority should be given to developing advanced civilian technologies which would then produce the necessary fall-out in the military sphere.

6. ET and the INF Treaty

Much has been written about the need to bolster conventional defences in the wake of the INF treaty, which in the view of some observers weakens the nuclear defence capabilities of NATO Europe as well as their coupling with the US central forces. In this view, the treaty makes it all the more imperative to energetically pursue conventional weapons applications of ET.

I shall not enter into the details of this discussion, which has had

perhaps stronger political overtones than strategic or military significance. It is however warranted to underline that on the one hand, as mentioned above, the trend toward decreased US nuclear committment in Europe has not begun with the INF treaty; and on the other hand that NATO and the US still retain ample forces to perform the strategy of flexible response, much as they did for the seventeen years which elapsed between its adoption in 1966 and the readying of the first operational INF in 1984.

Be that as it may, it does not follow that the need for ET in NATO strategy varies with the degree of dependence on the nuclear element. In fact, while it can be argued that ET would be needed to compensate for an ever higher nuclear threshold, one could just as reasonably propose that they should be used to strengthen and stabilize deterrence especially with low nuclear thresholds, since the latter would require all possible efforts to minimize the danger of accidental escalation. The kinds of ET outlined in section 5. above could be a useful contribution to exactly this goal.

In sum, there does not seem to be a univocal logical relationship between the desirability of ET development in NATO and whatever changes to the nuclear threshold might have resulted from the INF treaty.

However, the INF treaty is having an indirect, though potentially profound, effect on NATO security: it is forcing all allies through a careful re-examination of the transatlantic security relationship. Though many of the mutual concerns and recriminations are not new, it is probably not useless that the need for greater cooperation is reaffirmed one more time. In the field of ET, setting inter-allied priorities is one of the paramount and most urgent needs, and it has been remarkably difficult in the past.

7. The Case of ET in the Southern Region of NATO

A few words could be spent on the relevant peculiarities of the Southern Region of NATO for ET. Several participants at the conference noted how the technological gap between NATO and WTO forces is wider there than in the Central Front. The armed forces of the Southern tier of the WTO are generally much less modernized than their Northern allies, and the presence of Soviet forces, too, is both quantitatively and qualitatively less formidable.

This superiority might provide a favorable margin for NATO's exploitation of advanced technologies, particularly in the naval sphere. Launch platforms, torpedoes and target acquisition are some of the areas where these participants indicated both an objective military need for improvement and a promising technological potential to satisfy it. Yet, several factors do not bode well for the future prospects of ET in the Southern region.

First, these requirements, and their costs, will have to be weighed against comparative threat assessments for other regions of the alliance, aprticularly as far as the allocation of resources to US forces around the continent is concerned. To this day, the rather unimpressive Soviet naval presence in the Mediterranean, while by no means a negligible threat to our sea lines of communication, has been less than truly worrisome for overwhelmingly superior Western forces, and it has lacked any significant power projection capability to threaten NATO territory.

Second, political factors in the Mediterranean present some peculiar problems of their own, which compound the task of ET applications. Both the

recent episode of the F-16 removal from Spain and the continuing coolness of Greece toward alliance military initiatives in general highlight the problems which these allies would overcome in order to commit themselves to the kind of long-term joint military efforts which ET would require.

Third, some technical factors make the application of some ET more challenging in the Mediterranean. For example, the high temperature and high salinity of its waters, coupled with its relatively shallow and irregular depths, make the task for advanced underwater acoustic sensors particularly difficult.

Fourth, NATO members in the Southern region are, as a whole, less resourceful and less technologically advanced to invest in and absorb ET in their armed forces. Turkey, Greece and Portugal of course benefit from US technical and financial assistance, but American ability to keep it up might be waning. One American participant proposed that the richer Northern European NATO members should shoulder come of the burden of helping them with the United States.

Hence, to a first approximation, it is probably safe to predict that, because of both a lesser threat perception and a more constrained resource availability, expensive ET for naval use in the Mediterranean are not likely to receive as much attention as others for the use of land forces in the more crucial Central Region.