Click here for Full Issue of EIR Volume 14, Number 5, January 30, 1987

The European Defense Initiative: a near reality?—Part II

Carol White presents the second part of a proposal for an anti-missile defense of Western Europe developed by Gregory Canavan of Los Alamos National Laboratory.

The proposal under review here, is an article in the book, *Swords and Shields,* edited by Yost, Wohlstetter, and Hoffman, which is scheduled for publication in the near future. Gregory Canavan, who is the assistant division leader of the Physics Division at Los Alamos, concludes that by all existing parameters, the adaptation of the Strategic Defense Initiative to Europe would be both easier and cheaper than the defense of the United States. In this section, he also shows the added advantage of integrating a U.S. and a European system as one global unit.

Theater defense battle management is simpler than strategic defense battle management. Canavan explains: "Also of concern is the integration of the data streams from warning sensors, defensive platforms, and ground stations. In the strategic arena there are arguments pro and con about its practicality. In the theater, however, the threat is scaled down by about a factor of 10, and the defenses are reduced accordingly, so that the overall computational and control problems are reduced by a factor of 10-100, which should be tractable.

"The relative performance of the various boost-phase concepts is an important issue that has been analyzed extensively in strategic exchanges. For nominal performance parameters the predictions agree reasonably well that a constellation of 80-100 strategic satellites would be required to negate the simultaneous launch of 1400 fully hardened ICBMs. For the theater, the differences between predictions are even smaller. For a threat rate of 100 missiles in 100 seconds, or 1 kill/sec, about 20 defensive satellites of 20 megawatt-10 meter mirror performance would be required.

"If the defensive satellites are dedicated to the theater, however, a larger number of smaller satellites could be more efficient. The constellation required can be obtained by scaling the previous strategic results to the somewhat smaller launch areas and greatly reduced threat rates encountered in the theater. If the satellites' brightness is reduced by about a factor of 10, e.g. by deploying a constellation of 10-5 [10-megawatt chemical lasers with 5-meter diameter mirrors—CW] satellites rather than the 20-10s used for the strategic estimates above, the scaled constellation needs about 30 satellites, which is only about a factor of 2 larger than the constellation of 20-10 satellites that would be needed.

"The few, large satellites are so widely separated that even the distributed launch area looks compact to them. Only a few satellites are close enough to contribute effectively to the battle. The smaller, more numerous satellites are much closer together. Thus, more of them would be over the area at launch, which reduces their average range producing a more favorable scaling.

"Smaller satellites should also be about an order magnitude less sensitive to retargeting times and technologies as well as to other engineering issues, which scale primarily on brightness. And if the cost of a satellite is roughly proportional to its brightness, the cost of a 10-5 theater satellite should be reduced by about an order of magnitude from that of a 10-fold brighter strategic platform. Since the number of satellites would be reduced from strategic constellations by about a factor of 3, and the cost per satellite by a factor of 10, the overall reduction could be a factor of 30. Thus, if strategic satellites were to cost a few hundred million dollars, those for theater defense might cost a few tens of millions apiece."

Compared to the modest estimate of $121 billion for a fully-deployed ABM system of the sort outlined by the George Marshall Institute (see article, above), the theater defense would cost only $4-5 billion at most. Canavan continues:

"Then the theater constellation would cost about 30 satellites × $20 mm/satellite = $1B, although development, deployment, and support costs would increase this by a factor of two to four. It is also plausible that smaller satellites should be faster to develop and produce.

"In the boost phase there is a great deal of leverage associated with killing both MIRVs and decoys with the boosters. And in the theater, space laser constellations designed to do so are cheaper, smaller, and less sensitive to countermeasures, technology, and missile deployments than strategic constellations. Other directed-energy weapons share those advantages to varying extents. Ground-based lasers minimize both the mass in orbit and cost. Particle beams have unique advantages in lethality and in the discrimination of decoyed suppression threats. Both ground-based lasers and particle beams share the favorable constellation scaling discussed above for space lasers, and for platforms of the same brightness, their constellations are about the same size. Kinetic energy offers bulk lethality in the near term while maintaining an engagement window into the long term.

"Thus, boost-phase concepts should be able to provide an appreciable share of the total kill rate required, as well as reducing the threat to levels mid-course technologies could discriminate and designate for intercept by NNK missiles—or hand over to the endoatmostpheric concepts, which could then be very effective. Thus, strategic defensive concepts could work well in the theater—particularly in multi-tier configurations with balanced attrition."

Performance of layered defenses

Canavan further develops the argument that the anti-missile theater defense will prove cheaper than the costs for long-range theater missiles. No credibility should be given to those who sell our birthright—Western civilization—for a mess of pottage; notwithstanding it is clear that the European Defense Initiative will cheapen the cost of defending Europe. However, by any sane criteria, it is not necessary to have an exact balance between the cost of offense and that of defense. What after all is the price of those cities which would otherwise be destroyed?

Canavan continues: "Previous sections discussed the performance of the defensive concepts in isolation. This section treats them in concert, giving an approximate evaluation of their cost effectiveness and placing all factors that enter their evaluation into a consistent framework.

"The cost of the threat is a key element, but the only information on that subject comes from applying Allied costs to Pact forces. For the Allies the approximate costs for long-range theater missiles are roughly $20M per launcher. This discussion first uses that value for Pact forces as well and then assesses the sensitivity of the results to doing so at the end. Threat size and rate are also important. The 30-satellite theater constellation was derived for the simultaneous launch of 100 missiles accessible for 100 sec., or a peak threat of 1 missile per second.

"In a conflict involving many launches spread out over a period of hours or days, additional kills could be provided with the same number of satellites by giving each extra fuel, which is essentially free compared to the capital costs of the defensive platforms. A kill requires a few tens of kilograms of fuel. Even at launch costs of $1,000/kg that is only a few tens of thousands of dollars per shot, so that the incremental cost per kill in extended engagements would only be a few percent of the peak cost per kill. That simply reflects the fact that the peak threat rate sets the fixed cost through the platform brightness and constellation size required, while the extended rate pays only the variable cost for fuel.

"Boost phase [laser] defenses have large fixed costs but small variable costs, so the average cost per kill scales inversely with the size of the threat in extended engagements. For 100 launchers, defense with boost-phase lasers would cost about the $1B calculated above, giving a cost per kill of about $1B/100 missiles = $10M/missile. If the constellation is instead sized for equal contributions from each of four layers, the boost-phase allocation would only be 25 kills. For that the laser constellation could be scaled down by a factor of 4, reducing its cost to about $150M. Note, however, that the cost of the whole system increases by 20%. That reflects the admixture of discrimination elements, which are not efficiently utilized at low rates, as discussed below.

"If the threat is increased to an extended attack of 1,000 missiles, which are shared equally among the four tiers, the boost phase cost would drop to $1B/250 = $4M/kill, at which the boost phase would have a cost advantage of roughly 5:1. Boost phase concepts are particularly useful because they are effective against both high threat rates in simultaneous launches and large inventories in extended engagements. While stated for space lasers, this scaling also holds for hybrid lasers and particle beams. ["Hybrid laser" refers to a system composed of a ground-based laser and orbiting spaced based mirrors.]

"Midcourse costs scale differently. Assuming fixed costs of $500M and variable costs of $2M/kill, for 100 missiles, the midcourse defenses would cost about $500M + $2M/kill × 100 missiles = $700M. That gives $7M/kill; for 1000 missiles the cost would drop to $4M/kill. At the larger threats the fixed and variable costs are comparable. While these costs are rough, reasonable variations do not change the observation that the high fixed costs of the discrimination concepts make midcourse concepts more attractive for large threats where they can be prorated over many decoys.

"High endoatmospheric concepts' fixed and variable costs are reduced by a factor of two relative to mid course, but the patterns are similar to those seen in mid course. Costs are set primarily by fixed costs at low threat rates. The cost per kill there is $11M/kill. It decreases to $2M/kill at 1,000, which gives an advantage of 10:1. Low Endoatmospheric costs decrease by another factor of two but fixed costs are still dominant for small launches—about $4.5M/kill—though they drop to under $1M/kill for 1000 missiles.

"Summarizing, boost-phase and midcourse concepts for the nominal threat of 100 simultaneously launched missiles could cost $1B, relatively insensitive to cost assumptions. High endoatmospheric concepts would be lower by about a factor of three and low endoatmospheric concepts by a factor of six, if they could operate alone. If the choice was based on cost alone, only the terminal layer would be selected. But performance must also be included, since isolated low endoatmospheric defenses can be saturated or bypassed. It is necessary to estimate, as was done earlier, the threat each layer can handle.

"Strategic defense concepts could provide considerable leverage when deployed singly and even more when deployed in concert. The endoatmospheric layers serve both as an underlay to exoatmospheric defenses and as a stand-alone defense against shorter range missiles. The midcourse could both reduce the threat to a level they could handle and provide the information they would need to do so. And the boost phase operates, in part just by its presence, to filter RVs and decoys to a level the mid course can either kill or discriminate for endoatmospheric intercept."

Performance against other threats

Applying an ABM defense to the European theater allows the opportunity to merge a tactical anti-missile defense with a tactical defense against airplanes. Canavan develops how the space based laser can be used to shoot down airplanes, helicopters, and cruise missiles:

"The discussion above treated theater missiles, but the laser concepts can actually be applied to a wider range of targets, since they can deliver energy deep into the atmosphere—essentially to the ground. This gives them an ability to strongly suppress air breathing threats, nonnuclear theater threats, and non-theater nuclear threats, as well.

"*Aircraft*. Both space lasers and ground-based hybrids can deliver high-intensity beams to endoatmospheric targets. Thus, given detection of bombers and cruise missiles, it should be possible to destroy them like missiles. Their thin skins, lightweight structures, and high aerodynamic loads make them intrinsically no harder to lasers than missiles, and their long ranges make additional hardening impractical. An air breathing platform's survivability depends largely on its ability to fly close to the ground to make its radar and IR signatures in clutter. Laser attacks from above bypass those defenses. Detection and track of dim targets in clutter is difficult, but it should benefit from strategic research. It is also aided by the absence of decoys and the presence of auxiliary cues, such as the target's own terrain-following sensors.

"The tight geometry of the theater would help in localizing the search, and the target's modest speed gives adequate time to execute it, since search times are measured in thousands of seconds, rather than the tens to hundreds available for the engagement of boosters. And because these opportunities occur long after missile launch, searching for and intercepting air breathing vehicles should not interfere with the lasers' primary anti-missile mission.

"The number of vehicles in the air breathing threat would probably be comparable to the number of missiles, but the time for their engagement would be 10-100 times, and constellations sized for missiles would have kill rates far in excess of that required for the air-breathing threat. Lasers could defend against missiles for the first hundred seconds, midcourse objects for the next few hundred, and then air breathing platforms for the last few thousand seconds of the engagement. The same constellation would be roughly the right size for each, and the serial execution of these missions should not cause conflicts.

"These arguments only depend on the characteristics of the target vehicle, not those of the weapon it carries. They apply to nonnuclear aircraft as well. Burning a hole in an airplane's wing could require a few tens of megajoules of energy, which the laser could generate from a few tens of kilograms of fuel for a few tens of thousands of dollars. Since even conventional fighter aircraft cost around $10M, lasers could have roughly a 100:1 advantage in cost. The key is that the laser platform's capital costs have already been paid for by its missile defense role. Because of that the laser could be far less expensive than other means of achieving the mission.

"The suppression of nuclear weapons by strategic defenses could lead to the return of fluid conventional engagements with rapid strikes and deep penetrations for which concentration and surprise are pivotal. Disrupting and confusing such offenses is the most effective defense against them. Thus, space lasers, which could strike anywhere with little delay could have very high leverage in disrupting the sensors, communications, and control components needed to support such rapid concentrations.

"*Chemical and biological weapons* are an integral part of Soviet planning. There is also a strong incentive to destroy them in the boost phase to prevent any part of their payload reentering over one's territory. Dispersing the materials in space through midcourse or high altitude intercepts are also viable options. If, however, it is necessary to engage them in the atmosphere, there could be a significant advantage in intercepting them with nuclear warheads, which would minimize the uncertainty in the intercept and vaporize the active components.

"*Strategic Missile:* The suppression of theater launchers could cause the attacker to consider the introduction of launchers from outside the theater. Obvious candidates are the use of SLBMs or ICBMs on theater targets. On closer inspection, neither option is viable. Even if an SSBN [submarine] could release all of its missiles simultaneously, the threat rate so generated would only be about 10 missiles in 100 seconds, or 0.2 per second—an order of magnitude below that for which theater boost-phase defenses would be sized.

"Theater defensive constellation would be oversized by a factor of 10 to handle whole-boat launches, and strategic constellations would be oversized by a factor of 100. Releasing less would make the mismatch even worse. For the launch of a single missile the threat rate is only about 0.01/sec., which is about a factor of 100 below the capability of the theater defenses. Thus, such a launch would uselessly expose the SSBN in order to launch a missile that would immediately be destroyed. Moreover, the SLBM would be destroyed 'for free,' since the satellites involved are temporarily away from the theater proper, and hence would otherwise be dismissed as 'absentees' from it.

"Similar arguments demonstrate the futility of using ICMBs in selective support of the theater. Theater constellations would also provide, again via absentees, coverage for equal launch rates from Soviet ICBM fields. Satellite coverage is global. Thus, providing a given coverage anywhere automatically provides about the same coverage everywhere."

Survivability of space assets

Canavan writes: "The survivability of predeployed space assets has both technical and political components. The major issues that require analysis are the self-defense of individual satellites, the mutual defense of defensive constellations, and the identification of defensive constellations that are robust against sophisticated and deceptive suppression. For self-defense a lone satellite's tools are hardening, maneuver, and self-defense. Current satellites have little hardening, maneuver, or active defenses—primarily because there has never been a requirement for them. But using thick shields, replaceable components, and techniques already used on other strategic systems such as ICBMs and RVs—which are all extremely hard, though transient, satellites—it would be possible to increase the hardness of satellites by factors of hundreds. Efficient maneuver packages exist; they only have to be deployed. And self-defense could involve missiles little more complicated than air-to-air rockets. A combination of them would handle existing threats.

"The difficulty of self-defense increases if the attacker can deploy decoys and conceal its warhead. Properly arrayed, decoys could decrease the effectiveness of self-defense missiles inversely with the number of decoys per weapon. One counter is to reduce the size of the defensive satellite. For example, a satellite with 5-10 NNK missiles would have about the same mass as the attacker, and a satellite with a single missile would weigh a factor of four less, so there would be no incentive to attack it at all. Defensive platforms could also use decoys to confuse the attacker.

"Discrimination is the most powerful tool for self-defense against deceptive attacks. The use of lasers and particle beams to discriminate midcourse threats was discussed above. They should also be suited to interrogation of the suppression threat, which is just a decoyed missile launch targeted on the defensive platforms themselves. Eliminating the attacker's decoys reduces the engagement to a one-on-one exchange that is always favorable to the defensive satellite. Discrimination should also make it possible to sweep space and neutralize mines."

TABLE 1

Fixed, variable, and total costs for each regime

(millions of dollars)

	Fixed	Variable	One-layer	Multi-layer		
Threat (RVs)			100	100	500	1,000
Boost	—	1,000	1,000	250	1,000	1,000
Mid	500	2.0/kill	700	550	750	1,000
High Endo	250	1.0/kill	350	280	380	500
Low Endo	100	0.5/kill	150	110	160	230
Total	1,850		2,300	1,190	2,290	2,730

The integration of U.S. and European defense

In this section Canavan refutes the contention that there would be any trade-off between the United States having a Strategic Defense Initiative, and the defense of Europe. He writes: "Stability provides the framework for integrating the defenses' cost and performance with its military and political impact. The three main criteria that must be satisfied are crisis, arms control, and transitional stability. The first involves the identification of the defensive configurations that must be avoided to assure that neither side sees an incentive for preemption in a crisis, i.e., a situation in which one side can only assure its survival by striking first and using its limited defense to negate the other's 'ragged' retaliation.

"In the theater, crisis stability involves the identification of configurations where one's adversary might attempt to extract himself from a failed operation or prepare the way for an offensive by preemptively destroying the forces countering them. Either would involve nuclear forces. If strategic defense assets are not coupled to the theater, global stability analyses can be scaled down to theater force levels, predicting a broad channel for stable mutual deployments of defenses.

"The kill rates required, however, from strategic constellations are about a factor of 10 greater than those for theater defenses. Thus, a full strategic constellation could contribute about 10,000 kills in an extended engagement. Even a 10% completed constellation could contribute 1,000—and it could do so without interfering with its strategic role, which is executed by the satellites that are over the strategic launch area. Strategic satellites would also spend roughly as much time over theater as strategic launch areas, meaning that at every stage of deployment, strategic constellations would provide—at essentially zero cost to the theater—coverage better by a factor of 10 than they give to the strategic homelands themselves.

"It has been suggested that the development of capable defenses could let the U.S. and Soviets retreat behind their strategic umbrellas, making the theater 'safe for conventional war again.' But that assumes that strategic defenses would be more effective in defending their homelands than in protecting their theater allies, whereas the reverse would appear to be the case. Even imperfect strategic defenses could very effectively suppress theater missiles. Moreover, a major current difficulty in the theater is the uncertainty over if and when Pact forces might use nuclear weapons. Concentrated for defense, Allied forces are vulnerable to preemption; dispersed for survivability, they could perform poorly against fluid strikes. Providing defenses against nuclear threats would resolve this ambiguity and make it possible to return to conventional defensive formations more favorable to the Allies.

"Arms control stability concerns the response that defensive deployments induce in offensive force levels. Defenses induce changes in offensive deployments. That shifts the stability boundaries that govern subsequent decisions on the other side's defensive deployments. In assessing the stability of this feedback mechanism, the key issue is the cost effectiveness of the defensive increments. If they are cost effective, their introduction could be countered most cheaply by the deployment of defenses by the other side, in which case offensive force levels should decrease, or at worst remain fixed.

"In that situation defenses and arms control are mutually supportive, with defenses providing the positive incentive for arms reductions that appears to be absent in current negotiations. Only if cost-ineffective defenses were actually deployed would there be an incentive to increase one's offenses in an attempt to bankrupt one's opponent. For the cost estimates in Section V, layered theater defenses should have adequate margin to produce a stabilizing deployment. Current research efforts should thoroughly test those estimates.

"Transitional stability treats the conditions for a gradual transition from offensive to defensive force dominance. Two of the main criteria, crisis stability and survivability, were discussed above. The third, predictability, recognizes that an adversary's actions are driven not by reality but by his uncertain knowledge of the defenses under development. Thus, a defense-conservative estimate could lead to the premature deployment of cost-ineffective systems. Such instabilties could be reduced by timely exchanges of information on the testing of key components. For related reasons, significant advantages could also accrue to a joint U.S.-Allied evaluation of the concepts for strategic and theater defense, their impact on the theater, and the impact global deployment could have on the defense of the theater. The broad applicability of strategic defense concepts to the theater would make an independent evaluation unsatisfactory."

Overall assessment

Canavan concludes: "Previous sections discussed the framework for analysis and performance of strategic defense concepts in the theater. Each benefited from some aspect of theater operations. Boost-phase concepts benefit from the slower offensive missiles, shorter ranges, and efficient, survivable popup basing modes available in the theater—particularly in extended engagements. Lasers, particle beams, and kinetic energy concepts should all have useful roles in both the near and far terms. Their combination should make it possible to strongly suppress the deployment of both decoys and RVs, intercept multiple RVs before release, and achieve a robust level of survivability.

"Midcourse defenses benefit from the use of laser and particle beams for active discrimination and nonnuclear IR homing missiles for intercept. Similar interceptors could produce even cheaper kills in the high endoatmosphere, if provided with long-range discrimination from the midcourse. A common technology is passive infrared sensors, which are valuable both because of their compactness and their survivability.

"Against short range missiles, endoatmospheric concepts benefit from reduced decoys—no decoys in the case of short range missiles—and the enhanced survivability of hardened, mobile sensors and interceptors. The combination of technolgies also provides a strong counter to salvage fused and maneuvering threats. Nonnuclear kill could also provide a timely counter to nonnuclear theater ballistic missiles used in the early phases of an engagement.

"There is a strong interaction between the different defensive tiers, as well as a strong synergism between theater and strategic constellations. That should also produce a strong capability against both nonnuclear theater ballistic missiles and nuclear or nonnuclear air breathing vehicles. Theater defenses should be oversized against nominal ICBM or SLBM threats from outside the theater, and excursions could be handled by strategic assets without interfering with their primary mission.

"Survivability should be more robust than is generally thought. It should be possible to achieve it for ground based components through a combination of hardening, mobility, and passive sensors. Airborne sensors should be particularly robust. This combination of survivability and cost-effectiveness should also make the introduction of defensive concepts in the theater stabilizing, since they would inhibit the deployment of additional offensive forces, discourage preemption, and suppress other conflicts. Thus, the application of strategic defense concepts to the theater is a natural and positive corollary to their development in the strategic arena.