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Burros: Simple, Affordable, Effective Space Transportation

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BURROS: SIMPLE, AFFORDABLE, EFFECTIVE SPACE TRANSPORTATION

by

Gregory H. Canavan

ABSTRACT

The excessive capabilities of brilliant pebbles have generated fears that have driven them close to extinction. Simpler versions could apparently meet current theater and nonresponsive threats affordably without impacting strategic considerations.

I. INTRODUCTION

The Sangre de Cristo mountains of northern New Mexico are rugged and simple, as are the people who live there and the tools and animals they use to survive. Thus, it is ironic that "brilliant pebbles," the most sophisticated and capable defensive system developed since the war,[1,2] came from the humble region which also gave birth to the bombs.[3] It is tragic that the current excess capabilities of these recent arrivals relative to the threats they face have become an impediment to the evaluation of their ultimate potential and a threat to their survival.

Pebbles are too much, too fast. They are totally unlike the brute missiles they face, but they are on an even higher level of technology that is difficult to assess, assimilate, or accept. Thus, to many they appear as a threat to what little order and stability we now have. Perhaps in time they would be developed, understood, and even needed. But they may not last to see it.

This note suggests that their capabilities are more than is needed to meet the current threats from accidental, unauthorized, or third-world launches, which may be the greatest threat to their survival. Perhaps they should step back a bit; perhaps they could learn something from their humble origins.

II. BACKGROUND

Over history one of the least celebrated transportation systems has been the burro, which is Spanish for little horse, the sure-footed beasts that have carried the faithful over mountain passes to safety for centuries. They are not complex, but they are affordable and effective transportation. That is a relevant attribute, because defense in space is essentially a transportation problem. Given the limited energies of the fuels we have and the crudity of our rockets, it is surprising that we can reach space at all. If either was ten percent worse, we probably wouldn't have.

But we did--first with our machines, then our men, finally our weapons. Their combination, which could destroy civilization, if not life itself, established a balance of terror that has lasted forty years. But there are few who will argue that it will last four hundred, let alone four thousand, given the annual growth of those who can master[4] or buy the now commercial technologies of weapons and missiles.[5] In offensive deterrence, more is distinctly not merrier.[6]

Finally, the time came when it appeared that other machines could interrupt those intercontinental missions of destruction. Brilliant pebbles were born of that realization and were fueled by what then appeared to be an implacable threat. It was embodied in the thousands of missiles, tens of thousands of warheads, and millions of men who had produced and stood ready to use them. Pebbles seemed to be one of a few technologies that might restore the historical advantage of the defensive for all.

Those pebbles are not "brilliant" by accident. They must be so to withstand the full range of interactive countermeasures which render dependence on external sensors and controls

unacceptable against the full, interactive Soviet threat and the dedicated men who control it.[7] For that task only the most agile, rugged, and clever machines could suffice. But their brilliance meant that their development took time.

That time allowed or stimulated international developments. Some were good. A new Soviet leadership showed restraint in strategic forces, a grasp of the subtleties of nuclear deterrence,[8] and some inclination towards the reduction of tensions. Old tyrannies fell. Unfortunately, some new ones rose and quickly mastered the tools but not the manners of the missile era. The world was once again treated to the spectacle of the devastation of theaters, large scale use of missiles, and the indiscriminate slaughter of innocents. The missile attacks in the Gulf War were a horror show that confirmed old predictions and presaged things to come. The old order changed, but the new brought its own challenges.[9]

However, the space-based interceptors (SBIs) needed for protection against theater, accidental, and unauthorized launches should not, at least initially, face numerous countermeasures or cadres of trained attackers, so they should be allowed to take full advantage of external surveillance and warning, get by with less autonomy and survivability, use their payloads for more acceleration, and admit to broader release mechanisms than those for strategic defenses, which must act almost instantaneously.

Defense in space against these limited threats is largely a matter of affordable transportation. First, there is the matter of hauling enough SBIs into space for one to be near the launch. Then, there is the matter of flying one to the missile. Finally, there is the matter of positioning the SBI in front of the missile where it can be run over. The missile does all the heavy work; it kills itself. For limited threats, the missiles fly simple, blind trajectories and take no significant measures to interfere with the SBIs. In duels of machine against machine, all the advantages are with nimble, light SBIs over dumb, lumbering missiles.[10]

The fundamental distinction between these limited threats and strategic launches is not the type or number of missiles or warheads or even their ranges; it is their stupidity. Without the resources or requirement to second guess or attack defenses, the "third-world fanatic with nuclear weapons"[11] just points his missile, lights the fuse, and hopes for the worst. For such threats, no great brilliance is necessary, just proximity. SBIs just have to be close to missiles in their boost and midcourse phases, when they are most vulnerable and least threatening, and be able to get in their way--hence, the opening for good transportation, like burros.

Real burros need some intelligence to find their way. Even "burro pebbles" would still be impressive, but nowhere near brilliant. Fundamentally, that is because they would only have to work against other machines, not men. We pride ourselves on the speed and power of our toys, but the best computers still only have somewhere between one-thousandth and one-millionth of the speed of a man and even a smaller fraction of his subtlety. The pebbles we now call brilliant and their decade-old computers are a thousand-fold slower still.[12]

Thus, a mechanical pebble, no matter how shiny, is no match for a room full, let alone a country full, of smart and dedicated colonels and scientists.[13] If technology continues to evolve at the current rate, that balance might change in 20-30 years, but for now, getting away from large numbers of intelligent human adversaries is an enormous advantage that dwarfs all others.[14]

SBIs for theater threats could be so simplified as to represent "dumb" pebbles, which might even be built affordably by man born of woman without involving exotic sensors, circuitry, or leaving "hot" production lines for their city cousins. That is the second reason for the title of this note; for in Spanish, "burro" also means dumb. If so, they could arguably be developed separately and jointly with the Allies, arguably even with the Soviet Union, to achieve strategic defense's original goal: protecting the whole of mankind, not just a single nation.

III. GROUND-BASED INTERCEPTOR (GBI) LIMITATIONS

A decent respect for the opinions of those whose main lesson from the Gulf war was "let Patriots do it" demands that the limitations of GBIs be discussed in at least enough detail to permit their intrinsic limitations to be seen.[15,16] And establishing why SBIs are needed also goes a long way towards answering the question, how smart is enough?

It is difficult to hit decelerating targets, particularly if they maneuver. The miss distances for current proportional-guidance GBIs increase linearly with target maneuver and with the square of the interceptors' response time, which is largely set by their engagement altitude. The predicted miss is about 30 feet for a 1 g target maneuver and typical system response times of about 0.5 s.[17] Detailed calculations increase these miss estimates.[18]

In the Gulf War, Patriots engaged SCUDs at about 10 km where their deceleration was maximum and their disintegrating fuselages produced complicated trajectories with large transverse accelerations. Patriots have aerodynamic response times of 0.2-0.4 s; thus, they were expected to miss by tens of feet, and they apparently did. Their overall lethality could ultimately be assessed to have been in the low double digits.[19] This estimate is for targets with evasive maneuvers, but those maneuvers can be approximated by simple, slow spins.[20] Murphy's Law apparently also applied in the Gulf; pictures of SCUDs' helical trajectories suggest that they were so approximated in many encounters.

Patriot upgrades and replacements like ERINT will have improved on-board radars, but their response times will probably still be limited by practical guidance effects to similar values, so their miss distances should be comparable, from which it is difficult to achieve hit-to-kill.

US THAADs and Israeli ARROWs should ultimately intercept at much higher altitudes and use infrared sensors and thrusting to produce response times of $\approx$ 0.1 s, so they could achieve hit-to-kill. But even for SCUDs they would be degraded by the missiles' disintegration, which produces showers of fragments, which impact

radars much like decoys. For these reasons--and to address the release of multiple, chemical, biological, cluster, or nuclear weapons earlier in the trajectory--boost or midcourse engagements are desirable, for which SBIs are uniquely qualified.

In comparing space- and ground-based defenses, costs matter, but scaling arguments largely suffice to bound them.[21] The hardware costs for optimized GBI defenses against typical 100-missile threats are about $150M for 650 km range enhanced SCUDs; $600M for 1,300 km intra-theater missiles; and $2.4B for 2,600 km inter-theater coercive launches against US troops, Allies, and cities and capitals abroad. Because GBI costs increase rapidly with missile range, it is not unexpected that SBIs, which are distributed globally, could be cheaper at longer ranges.

IV. REQUIREMENTS

Numbers also matter in SBI analysis, but technical arguments about the role of space elements in theater defenses can again be discussed adequately with simple scaling arguments to the levels needed to support discussions of broader issues. For range R of interest,[22] missiles launched on minimum-energy trajectories of range R have flight times proportional to $\sqrt{R}$.[23] For R = 1,000 km, T ≈ 450 s. SBIs with sensors that can detect theater missiles and weapons and intercept them at apogee have fly-in times of T/2, so SBIs with average velocity V ≈ 6 km/s could engage from ranges $r < V \cdot T/2 \approx 1{,}350$ km. Each can defend an area of $\approx \pi r^2$, so the total number needed for theater coverage is $N \approx R_e^2/r^2 \propto 1/R$, where R_e is the Earth's radius.[24] For R = 1,000 km, N ≈ 23; for 2,500 km, N ≈ 9.

Unless missiles are launched within a few minutes of each other, the movement of the SBIs in their constellation brings new interceptors into position, so for longer intervals the defense needs N SBIs to fill the constellation plus M for the intercepts. If SBIs have variable costs s ≈ $3M per SBI, the total cost is ≈ s(M + N). For R = 2,500 km, N ≈ 9, and the cost for M = 100 missiles is ≈ $3M(100 + 9) ≈ $330M, which is only about 6% of the cost of a GBI defense at that range.

Depressed trajectories could, at the price of increased missile size or reduced range and accuracy, attempt to underfly the SBIs.[25] That could increase SBI "absenteeism" by a factor of 2-3 but would not significantly impact SBI cost effectiveness for trajectories of interest.[26] The increase in absenteeism because of depression is small compared to the factors of 8-30 which SBIs could accept in order to intercept fast missiles in their boost phase rather than midcourse before weapons can be deployed.[27]

V. INTERCEPTOR MIXES

GBI costs increase rapidly with missile range; SBI costs fall with range. For typical GBI and SBI costs, the break-even range for a single theater is roughly 1,000 km. For shorter ranges, GBIs are preferred; for longer ranges, SBIs are. If for threats of M = 100 missiles, GBIs were used at 2,500 km ranges, where SBIs were economically preferred, costs would be increased by a factor of almost 20. If several theaters must all be protected at the same time, SBI costs are essentially unchanged, but GBI costs increase by the number of theaters. For the eight or so theaters that could emerge in the next decade, the break-even range would fall to about 500 km--even further with increasing interceptor velocity--which could favor burros.

In this simple break-even analysis, the most important parameter of the SBIs is their brawn, not their brains. The SBIs' most important abilities are accelerating quickly to high speeds and penetrating deeply into the atmosphere to reach short-range missiles. Interestingly, the greater weight and size of the brilliant pebbles' sensors means that their acceleration is lower and their sensitivity to sensor heating during penetration is greater.[28] For that reason, burros might be preferred on a straight performance basis for theater intercepts.

For threats with missiles of several ranges, this simple break-even analysis is replaced by minimizing the total cost of the combination of GBIs and SBIs used.[29,30] In general, a mix of GBIs and SBIs is preferred for all but the smallest number of near-simultaneous launches in a single theater.[31] Performance

and cost dictate proper mixes for global protection against limited strikes (GPALS).

For theater threats that include chemical, biological, cluster, or nuclear weapons, there are also great advantages in intercepting missiles in the boost phase before their weapons can be released. This qualitative advantage is sometimes difficult to quantify, but it was never difficult to explain to those in the Gulf War who were exposed to such types of attacks. Boost-phase intercepts are possible with SBIs; generally not with GBIs.[32]

VI. GEOGRAPHY

A seemingly technical aspect of theater defenses, but one that could effectively isolate them from strategic defenses, is the possibility of deploying SBIs or directed energy weapons (DEWs) at low latitudes, where they could do an adequate job of suppressing theater launches but could not impact Soviet intercontinental ballistic missiles (ICBMs) at all and would have only marginal impact on submarine-launched ballistic missiles (SLBMs).

By deploying SBIs or DEWs at equatorial latitudes of 20^{o}-25^{o}, it should be possible to achieve adequate performance against a few theater missiles with approximately 100 SBIs, which would have no significant impact on Soviet forces.[33] Protection against limited SLBM launches could be added without significantly impacting ICBMs; protection against limited ICBM launches could be added with only marginal impact on deterrence.

The objection might be raised that the SBIs might, after deployment, shift themselves from their equatorial orbits to the 60^{o}-70^{o} needed for effectiveness against Soviet ICBMs. That shift would, however, require expenditure of much of the SBIs' limited fuel. A simple calculation on equilateral triangles shows that shifting from 0^{o} to 60^{o} would require all of the SBIs' fuel. Even smaller shifts would leave them essentially inert.

It could also be posited that a "hot" production line for burros would make it possible to more quickly deploy more of them

further north. But if each burro was unable to protect itself against anticipated countermeasures and attacks before launch, the deployment of more, similar burros would have no effect. If you lose on every transaction, it is hard to make it up on volume. Burros should be strategically transparent.

Thus, to the extent that proper attention was paid to sophistication, deployment latitudes, and numbers, burros could be deployed with essentially no capability against Soviet strategic launches or impact on strategic stability or the ABM Treaty, which is silent on such purely theater defenses. As noted below, the possibility of geographically isolating such theater defenses also works for directed energy weapons.

VII. SPACE SENSORS

It is now widely accepted that space is the most efficient base for sensors for early warning, threat assessment, and efficient interceptor allocation and control. SBIs need warning and target trajectory information; burros would be even more dependent on external sensors. There are two possible sources of information. One is the current capable warning sensors at geosynchronous altitudes. Virtually all of the warning, attack assessment, and interceptor allocation tasks could be allocated to them. Indeed, some steps in that direction were taken during the Gulf War.

The other is external sensors such as the Defense Support Program (DSP). There are, however, reasons for not relying on them totally. For one thing that could be seen as setting a precedent for their later control of strategic defenses. And as a practical matter, those satellites were primarily designed for assessing attack certainty and size, not the precise trajectory and impact points of individual weapons. Spatial and temporal resolutions from geosynchronous satellites could be too coarse to provide useful intercept information to burros. The satellites could, of course, be improved, but there is an alternative.

It has been noted that the "brilliant sensors" from brilliant pebbles could be deployed on nonpropulsive satellites

to provide constellations of numerous, low-altitude "brilliant eyes," whose space and time resolution could be better by orders of magnitude. Such eyes could provide more than adequate information to guide burro intercepts.

It could be objected that they would be useful for guiding brilliant pebbles as well, but as long as the low-altitude eyes were not hardened or equipped with other aids to survivability, they could be destroyed or negated by precursor attacks, so they would also be transparent and decoupled from strategic defenses. As such they could be developed and deployed with the allies, arguably even with the Soviet Union. Given the powerful and critical auxiliary roles of "brilliant eyes" in measuring global weather, pollution, climate change, and natural disasters, the advantages of full cooperation would appear overwhelming.[34]

VIII. DIRECTED-ENERGY WEAPON (DEW) CONCEPTS

As noted above, the advantages discussed for burro SBIs could also be shared by theater or limited-strike burro DEWs. In particular, their deployment at low latitudes in small numbers could effectively isolate them from strategic considerations.

DEW performance in theaters can be assessed almost exactly.[35] Apart from development time, lasers are better than SBIs for ranges under 300-500 km and only slightly inferior to them for ranges over 700-900 km.[36] The lasers needed could be integrated from levels of technology that have already been demonstrated;[37] hence they could arguably be in place in a decade,[38] when theater threats requiring them could become acute.

Neutral particle beams (NPBs) are superior to either for long range missiles because they can both kill and discriminate decoys efficiently.[39] For the defense of Allied value, or of the US against the accidental or unauthorized launch of SLBMs, NPBs based on demonstrated technology popped up on warning could discriminate the decoys and kill the weapons from the missiles from several submarines.[40]

NPBs would thus represent a useful development in theater and US protection. They could also represent a hedge against the resumption of the central strategic competition, although again

burro NPBs would not need the performance and survivability needed and hence not provide a hot path to it.

Thus, given the difficulties of GBI intercepts and the sensitivities of SBIs to fast missiles and depressed trajectories, it is legitimate to regard DEWs as the climax defense for theaters and limited strikes.[41] And burro DEWs are adequate, non-threatening simplifications of strategic DEWs in the same sense that burro SBIs were acceptable and effective simplifications of brilliant pebbles.

IX. STABILITY

It has been noted above that proper deployment could prevent burro SBIs or DEWs from impacting strategic considerations at all by depriving them of any strategic capability by their deployment or simplification. It is interesting to note that the levels of deployments needed for GPALS would not adversely impact the arms control or crisis stability of the strategic balance with the Soviet Union in any case.

According to the accepted deterrent calculus, the few hundred GBIs or SBIs needed for GPALS could be deployed without significantly degrading indices of crisis stability.[42] Deploying both should actually increase them.[43] The greatest concern is the uncertainties in that calculus,[44] but they should be minimized against theater, natural, and isolated opponents.

It should be noted that in assessing likely impacts on stability, assessing the performance of specified SBIs is relatively straightforward; the more complicated and uncertain process is assessing the sensitivity of GBI underlays to unknown and unsuspected penetration aids and decoys. For theater defenses, burro SBIs that intercept in boost would minimize such uncertainties.

X. FURTHER CRITICISMS

A number of the criticisms that can be addressed to the joint deployment of limited numbers of burro SBIs or DEWs, like the issues of hot production or redeployment in orbit, were

answered in the course of the discussion above. Burros should have no strategic impact on either. Their inability to overcome even crude Soviet countermeasures would be an asset in this light; it should also remove any incentive for the Soviets to develop and deploy penetration aids and decoys that could degrade defense effectiveness if used in accidental or unauthorized launches.

This point is fundamental and goes to the heart of the difference between protection and defense. If SBIs were designed to maximize performance, which was not to be disclosed, Soviet planners would feel pressure to invent measures to overcome the SBIs in case of a deliberate attack. If deployed for strategic launches, such countermeasures could be activated on accidental or unauthorized launches as well, with catastrophic consequences, particularly for GBIs.[45] If burro SBIs were designed for protection against third-world measures only, they should generate no such escalatory pressures.

Theater launches require defenses. Against fanatics there is no deterrence, only defense. But for other threats there are even simpler and arguably cheaper solutions than burros, such as permissive action links for protection against unauthorized launches and destruct after launch mechanisms for minimizing the damage from accidental launches. Both are potentially so useful for ICBMs that we should have full cooperation on them already. We don't. Maybe the pressure of burros could speed their acceptance. After all, we had little motion on strategic reductions until SBIs were explored.

And some form of burros or SBIs would be needed for theater and SLBM launches in any case, and permissive action links and destruction after launch are harder for submarines that survive through autonomy and lose contact with their missiles at launch. Besides, having links, destructs, and burros would just be a form of belt-and-suspender protection that is well justified until such threats could otherwise be eliminated.

That burros at low latitudes would still have some modest capability against SLBMs from close to shore is a blemish. But

it has been pointed out by senior defense advisors that such deployments are no longer necessary, given longer-range SLBMs; hence such deployments would in themselves be provocative and might be reduced or eliminated through political agreements. The value of such agreements, which would be useful in any case, might actually be enhanced through the provision of some mechanism for policing them, like burros.

On the surface, the biggest concern appears to be that the deployment of SBIs could appear to violate the ABM Treaty. But the deployment of manifestly theater burros that by design or deployment had no capability against the strategic launchers contemplated by the Treaty should not do so. On such purely theater defenses the Treaty is silent. The main arms control issue thus reduces to the concern that even a small deployment could act as a stepping stone to larger deployments. But if each burro has zero strategic capability and significance, that would just be a stepping stone to a bigger zero. Burros would remain strategically transparent at all levels of deployment.

Even with respect to the ABM Treaty, there is apparently some US and Soviet openness. There are offers to discuss and amend it modestly in order to increase the effectiveness of coastal coverage by GBIs,[46] even though that would be a step in the direction of the area defenses to which the Treaty is fundamentally opposed. Surely, modest modification to permit the deployment of burros for threats, most of which would never approach the US or Soviet Union, would be a simpler matter.

There are questions as to political acceptability, but one energetic, young reporter took the unprecedented step of asking the principals about it.[47] The response from the DoD's Strategic Defense Initiative Office (SDIO) was that it was "'just an idea,' one among many under consideration." That is indeed good news, given the general impression that the SDIO is lacking in such options.[48]

Likewise, congressional sources downplayed the idea. They said they have been aware of the idea for some time, but resisted it because the system might, like GPALS, prove to be just a

stepping stone toward an all-out strategic defense. That is indeed a concern for the brilliant pebbles currently envisioned for GPALS, but not for burros specifically designed and deployed to have no such capability, as discussed above.

It is also said that such dumb SBIs might "do little to allay Soviet concerns." Given the confusion unearthed in the two previous paragraphs, one might profitably ask the Soviets about that. A rough synopsis of where things stand today is that senior DoD spokesmen duck the suggestion by saying that it wouldn't address congressional concerns, and top congressional leaders fear that it might not allay Soviet concerns.

Not surprisingly, the indications from the Soviets, who seem to have become more keenly interested in such issues[49] after having accidentally launched one of their missiles recently,[50] are that the US DoD would have to cut them some slack. It would seem that running this daisy chain one time in reverse could clear up a lot of confusion.

Given that the idea was "devised a few years ago," the SDIO and Congress have been "aware of the idea for some time," the Soviets appear to have increasing interest, and there are no obvious technical objections, the average taxpayer might well ask why so little has been done to investigate or develop it.

The answer again appears to have its origins in the mountains of New Mexico. The original concept for brilliant pebbles was in fact quite close to the burro described here, as is clear from even nontechnical descriptions.[51] But it was weak on performance, long on survivability, and unacceptably dependent on external sensors and control. As often happens as projects are transferred from the senior to the junior design laboratory, the priorities got reversed in development, and burros became--or rather came to be described as--brilliant pebbles.

The obvious problems were fixed, the design was frozen, the (domestic) forces were deployed, and the battle was joined. It happens every day. The battle over whether to pebble or not was so noisy that the major participants hardly noticed even when the Soviet threat was legislated away and another set of theater and

limited strikes arose.[52] In an amusing self-deception, the tawdry staffs of the "third-world fanatics" were suddenly credited with the characteristics of the Soviet General Staff, who were otherwise engaged, in bread lines.

This would all be good fun if the unintended consequences weren't so potentially serious. Good and well-intended observers in Congress and elsewhere[53] did not miss the fact that somehow the cure now looked worse than the disease. Unable to achieve meaningful dialogue with the Administration, they then threatened to shut down the whole game. The cure is technically simple: go back to the appropriate solution for theater and limited strikes: the lowly burro.

Politically that seems hard. There is a lot invested by now on both sides on either building or killing the brilliant pebble. A shift to burros would be viewed as a cop out by one side, a sell out by the other. Unlike most budget battles, which are usually desperate but not serious, this one is both. There are people in very real theaters who will die in the next decade if the wrong choices are made, or even delayed.

There is a compromise that could avoid that: develop the burro; deploy a few for theaters. If they work, discuss with the Soviets the option of building a few more for accidental and unauthorized launches. Better yet, build, deploy, and control them jointly with the Soviets so that there is no possible confusion over their capabilities as protection and limitations as defenses.

Is this the original "star warrior" selling out the Reagan dream?[54] Hardly. Chairmen Nunn and Aspin have the votes and the money. Their will be done. Brilliant pebbles will probably go back into long-range R&D whether or not this paper ever sees the light of day. The real issue is whether that action will just leave a black hole in the space defenses needed for existing and projected threats or if burros will be kept on line for them so that the brilliant pebble can have the protracted development it deserves in case it is ever needed. Too close to call, but at least it seemed useful to put the real issue on the table.

XI. INTERNATIONAL DEVELOPMENT

A final coda on international development and deployment. Such things are hard for brilliant pebbles because they must, of necessity, use the latest and the best, but keep technologies, parts, and expected performance out of the hands of the biggest collection of B-movie spies in the world, who have nothing else to do just now. With burros it could be a snap.

Since there is no need, or desire, for "three nines" nuclear performance and the like, burros could be built with Radio Shack parts. And it could be done for a fraction of the cost. Rather than have the major defense contractors who have been industriously carving up the brilliant pebbles pie for the last few years equip each with the latest, incompletely developed gadgets, we could just state what you want and go out on open, unclassified bids. That would surely end concerns about transferring classified information and critical technologies.

Sounds too easy; it probably is. But it leads into a point: If the big problem with SBIs is widespread fear over what they might do, the best way to allay those fears could be through a joint development, including the Soviet Union, of burros that didn't hide anything. President Reagan only asked us to get rid of the missile threat; he didn't say anything about having to do it without the Soviets.

Having said that, it is clear that such development could also lead naturally into joint control of the burros for the good of all. Putting a Soviet man in the loop is better than having him outside wondering what is going on inside, fearing the worst, and planning how to beat it. There should be very little downside. Burros that were designed in excruciating detail to have no impact on Soviet forces could have precious little adverse effect on US deterrents either. At a minimum, a serious effort to split off, share, and develop a nonthreatening level of badly needed space defenses could generate budgetary pressure that would act as an incentive to pursue other arms control measures more aggressively.

XII. SUMMARY AND CONCLUSIONS

This note argues that space is the best place to put not only the sensors, but also the SBIs and DEWs needed to address long-range, intra- and inter-theater missiles efficiently. There are real threats; they are likely to worsen. Ground-based defenses cannot handle them all affordably. Mixes are generally appropriate. There is a role for SBIs, but it doesn't appear to require all of the capabilities built into the current SBIs at the outset.

The SBIs that are needed now could be no more than cheap burros that were amenable to joint development and robust command for the protection of all. Their deployment for GPALS should not adversely impact the arms control or crisis stability of the strategic balance with the Soviet Union in any rational, concrete calculus, including that used by the Soviet Union. Deployment at low latitudes should give them adequate capability against theater launches but none against Soviet ICBMs and only marginal, residual impact on SLBMs.

They should not either leave hot production capability of anything threatening or provoke untoward responses. We have a hot production line on Chevrolets that would pose more of a threat to the Soviet Union. Their inability to overcome even crude Soviet countermeasures would be an asset in this light. A companion effort could develop the brilliant eyes needed to guide them. A similar logic is possible with DEWs, but they are less developed and hence less at issue.

The biggest concern appears to be the possibility that they would appear to violate the ABM Treaty. But if their capability against strategic launchers could be reduced to insignificant levels, the Treaty would fall silent. There appears to be grounds for discussion of the issue domestically and with the Soviet Union, but there seems to be little.

There are valid historical reasons why the capabilities of SBIs so overstep the threats they face. But the unwanted applications enabled by those excess capabilities appear to be

the biggest threat to them and can no longer be taken lightly.[55] The forces are joined.[56,57] It is unlikely that any outcome can be produced that would do justice to the parties, the technology, or defense. It is time to take a fresh look--or rather, look at an old one again.

That seems hard politically; but the alternatives are worse. So why not develop and build a few burros? Better yet, build, deploy, and control a few jointly with the Allies and the Soviets so that there is no confusion over their capabilities as protection and limitations as defenses. The only real issue is whether returning pebbles to research will leave a void or the needed burro in the center of space defense.

At present, the biggest impediment to the development of such defenses appears to be the excess capability of brilliant pebbles relative to the reduced theater, accidental, and unauthorized launches they now face--and the fears generated by uncertainties over other purposes to which that excess capacity could be put. This note suggests that perhaps it is time to step back, recall something from their humble origins, and split space defenses into a nonthreatening herd of eyes and burros developed by all, for all, and a second pride of brilliant pebbles that is the subject of properly classified, proprietary long-range research that is done carefully with the hope and expectation that it will never be needed. Such a two-step approach could be simpler, cheaper, and safer for all in the long run.

Current brilliant pebbles embody our highest technology and goals. Their creators and advocates are rightly proud of them and correct to defend them in the absence of a less threatening but capable alternative. But those very capabilities make them appear menacing to many, which could deny them to us when needed. We don't know the future; we don't know what we will need to cross the pass. But sometimes it is best to take long trips one step at a time.

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