KILLER BEES, NEGATIVE GATES AND HIBERNATION: AN EFFECTIVE SDI SYSTEM FOR DEPLOYMENT NOW

by

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I. The "Kinetic" SDI Options: Current Technology and Outlook.

The interception of (nuclear) ballistic missiles immediately after launch is the foremost promise of the Strategic Defense Initiative ("SDI").

The need for an immediate deployment of an SDI capability for operational readiness in the 1990s is self-evident:

(1) intercept of **accidental launches,** the "impact cost" of which by itself ($10 billion to $100 billion+ randomly over the US) would justify the whole system cost;

(2) **Soviet "social systems instabilities" in the 1990s**, not dissimilar to those plaguing the demise of the Austro-Hungarian empire which did lead to World War I;

(3) **Rogue Soviet submarine** commanders, particularly if composed of dissident non-Russian nationalities or radical left-wing ideologues (Stalinists);

(4) **Third country missile threats**.

Lest one forget, the movement of the Soviet Union toward more democratic forms of government and decision making is a recent one, and violent reactions within the Soviet system to these positive changes will be a major de stabilizing element in world relations over the next decades. After all, after hundreds of years of dictatorships of one kind or another, and in view of a multitude of nationalities, faced with the "decentralizing" forces of economic reform, it would be too much to expect such dramatic change to occur without the prospect of major violence.

This primary factor for potential instability and strife of **a nuclear power** is the primary reason for the need to deploy SDI now.

A variety of options are being pursued by SDIO, the kinetic systems having the greatest immediate (next decade) promise.

Much has been made by the ideologues of the **MAD (Mutual Assured Destruction)** doctrine, and their stealthy allies in some of the academic community, that "SDI" is not workable for the next decade, and hence should not be considered other than for research purposes. These critics studiously ignore that

(1) the Soviet Union already has deployed an SDI system for terminal defense around Moscow and continues to upgrade and improve it with technologies based "**on other physical principles**" (the language of the ABM treaty text, e.g. fiber optics); and

(2) the KKV (kinetic kill vehicles) technologies have rapidly advanced over the last few years to a point where the technical ability to intercept ICBMs in the all important **boost phase** (the first three minutes) is assured with high probability: after all, evasion, camouflage, deception is close to impossible in a massive event such as the launch of an ICBM.

While substantial progress is being made in this and related areas, the key obstacles to kinetic SDI systems as proposed by SDIO (KKV Garages etc.) certainly include:

(1) **Complexity of detection, tracking, guidance, CCC** and associated data processing requirements. In most SDI system designs, these nodes are highly concentrated;

(2) **Vulnerability** of these concentrated nodes and the KKV "garages" themselves, and the CCC system;

(3) **Distance of the "garages"** to the missiles to be intercepted;

(4) The need for **multiple launches** from any one "garage" at the same time;

(5) **Power requirements** for station keeping;

(6) **Maintenance and refurbishment** of the system;

(7) System monitoring and testing to assure **operational readiness;**

(8) **Probability of intercept**, given the distances to the likely targets to be intercepted - with further CCC requirements imposed on the defense for co-ordinating the relatively many missiles not killed in the boost phase. Decoys and countermeasures become orders of magnitude more effective after the boost phase.

(9) The "Nitze" **cost effectiveness criterion "at the margin**" (cost combined with probability

of intercept of missile(s) vs. costs of additional missiles or evasive measures).

Many of the systems considered by SDIO require extremely centralized co-ordination, command, control and communication functions on a global scale. In part these functions are imposed by the technologies considered (directed energy systems, KKV clusters), in part they are due to "Cultural Habits": it is difficult to convince central planners of the efficiency of decentralized market economies, and military professionals of the advantages of dispersed, unco-ordinated guerrilla warfare.

Furthermore, the notion continues to persist, that the interception of nuclear missiles itself is a potential trigger for holocaust scenarios, while the fact is that KKVs have minimal destructive (explosive) effects.

What is needed is a simple, primitive system with close to 100% intercept capability. This is only possible by radically increasing the Entropy (dispersion without central control - i.e. chaos) of the system design.

Such a radically different system is proposed herein: **BEE KKVs**. The underlying philosophy of the proposed system borrows heavily from basic propositions and insights long proven in economics, in risk management and in the theory of games.

On the technical side progress has been so vast, that recently Lowell Wood of Livermore has proposed "brilliant pebbles" of very limited size and cost ($50,000 or less per "pebble") for kinetic intercept of ICBMs. While indeed technology trends clearly make these devices feasible within current technology developments (say a phase 2 KKV system for the late 1990s), one can proceed immediately with the deployment of individual KKVs of extreme simplicity, high reliability and a close to certain intercept probability of individual or a selected few ICBM launches.

Three main obstacles have plagued KKV systems:

(1) when "bunched in garages, the **average random distance** to the ICBM may be 400 miles, imposing severe requirements on intercept speeds and ranges for the KKVs "at the margin". The "bunching" was deemed necessary because of the complexity of the energy, optics and command control and communications requirements for KKV uses if co-ordinated centrally;

(2) the **vulnerability** of the detection, tracking, command, control and communications nodes in a centralized system; by destroying these nodes, the KKV SDI system is rendered ineffective.

(3) the vastness of the **software** required to run/operate such a centralized KKV-SDI system.

To overcome these difficulties, a radically simplified KKV SDI system is being proposed, in analogy to the logic governing bee colonies: **individually deployed KKVs capable of independent detection, optimization and interception within its assigned coverage "circle".**

Research has shown that bees are able to locate "targets" autonomously with a minimum of energy, information and intelligence, yet do so over long distances using economic flight patterns.

To appreciate the feasibility of a totally decentralized SDI system, the "critics" should remind themselves of the following simple facts:

(1) the proposed KKV systems **can not intercept or cause damage within the atmosphere** since each KKV will burn up during "accidental" re-entry: it has no ablative protection, nor does it need such protection in space. Hence the nightmares of "Unauthorized" activation causing World War III are imaginings;

(2) KKVs can only destroy ICBMs **AFTER LAUNCH:** what possible reason can be advanced not to attempt to intercept such objects - with megaton nuclear warheads on them - at the earliest possible time right over the enemies territory? What is gained by waiting for these objects to reach domestic shores before intercept, or worse, to have no ability to intercept such missiles as is the case today for the US - albeit not the Soviet Union?

II. BEE-KKVs: A High Entropy Simple Autonomous KKV System.

The "BEE-KKV" system consists of autonomous KKVs with

(1) initial "**technology demonstration" deployment of 100 to 200 units** in "conformance" with the spirit of the ABM treaty and the recent proposal by Senator Nunn on the need to indeed have such a capability (albeit in Nunn's case only a terminal one) - estimated total costs about $1 billion;

(2) Deployment of **up to 10,000 individual KKVs** after the technology demonstration phase and without Soviet agreement to radical reductions in ICBM forces as proposed by President Reagan - estimated costs about $10 billion;

(3) **Autonomous intercept capability** of each KKV when turned **ON;**

(4) A "**Negative Gate" CCC structure**: KKVs within CCC communications beams are **OFF** (dormant), while cessation of CCC links turns KKVs **ON** for autonomous detection and intercept;

(5) **Hibernation** state of **BEE-KKV**s for most (all) the time in non- crisis situations. Just as in hibernation "test" interrogations and other minimal functions would be performed to maintain operational readiness during dormancy;

(6) A **"minimax" KKV intercept strategy**: intercept of the minimum distance (closest to the decision center) enemy missile within a maximum (programmable) operations horizon;

(7) A **two-dimensional** ("**bee type**") intercept logic based on tracking distance within the decision circle;

(8) **Supplemental refurbishment "hives"** in space, at sea and on land with, say, up to 100

KKVs per hive, capable to release KKVs on demand.

The keys to the efficiency of this approach are

(a) the "**Negative Gate**" and **Hibernation** Approach: it allows most (all) KKVs to be dormant most of the time, thereby minimizing the exorbitant power and fuel requirements incurred by constantly active systems;

(b) the **two-dimensional "bee-type"** intercept logic allows the KKVs to operate with minimum positioning knowledge (up or down): the KKV will home in on the target by observing parameter changes (e.g. two-dimensional distance) over time (proportional guidance).

(c) the **high degree of dispersion and autonomy** (disorder, entropy) of the deployed KKVs, with a minimum of central control and co-ordination: random distances to boost-phase intercept targets are minimized, vulnerable nodes are eliminated.

(d) a **maximization of "survival" chances** against primitive or sophisticated countermeasures aimed to destroy the KKVs. The cross-section of these BEE-KKVs is an order of magnitude smaller than the KKV garages contemplated by SDIO. Also, some primitive countermeasures can not be effectively employed against these highly dispersed and numerous KKVs, since doing so would effectively deny access to Space to the enemy power as well. In addition, the kill probability for eliminating the BEE-KKV capabilities would remain small: there are no central assets of any kind to be destroyed in the most basic case. What is not there can not be destroyed.

The approach is not dissimilar to changing a centrally planned economy to a market driven decentralized system with local optimization.

In addition to the primary "Negative Gate" systems design, a variety of simple, or complex, systems can be superimposed to activate individual KKVs, or groups of KKVs.

"BEE-KKVs" can be deployed based on **current technology,** at **minimum cost**, least complexity, **minimum vulnerability**, and great **assurance of boost-phase intercept**. The system provides global coverage and intercept capabilities equivalent to KKV reliability.

Just as in economics the idea of a vast central "computing authority" with all the attendant data processing requirements is vastly inferior to the **decentralized approach** taken in market economies, where each individual optimizes within his horizon and with the information available to him, so it is in SDI: a highly dispersed, **"chaotic", and autonomous** system - at the lowest possible "individual level" - should vastly simplify the system requirements, increase the efficiency of the system and maximize the likelihood of intercepts - particularly in the most critical and productive boost phase. Such a "**High Entropy**" system is:

(1) A totally **'dispersed'** system, in that each kinetic kill vehicle is deployed separately - e.g. 10,000 (as against 100 'garages' with 100 KKVs or 1000 garages with 10 KKVs);

This would roughly double the number of known manmade Space objects in Earth orbit.

If equally spaced, **each KKV would cover about 20,000 square miles from 200 to 300** miles altitude. More efficiently, the KKVs should be dispersed in a combination of polar and medium inclination orbits to maximize coverage of enemy sites - fixed and mobile.

Special coverage can be provided for clusters of enemy missile deployments: through orbit and deployment optimization and back- up "**BEEHIVES"** in stand-by orbits, launch on demand from land or sea, deployment of **BEESWARM**s over ICBM clusters.

Minimax algorithms can be developed to optimize such dispersal patterns. Given the high number of KKVs, a variety of "**mixed strategies**" can be used in the deployment and operation of this dispersed system.

(2) **Each** BEE-KKV is made **fully 'autonomous',** in that it is capable of acquiring and discriminating launch vehicle 'signatures', and when so recognized will initiate itself to launch and intercept (unless overridden) by a central CCC in an "active management" option (if affordable or survivable);

(3) Its decision whether to intercept or not will be based on (variable) **minimax** distances - without any central co-ordination, and minimum co-ordination with its 'neighbors' in maximum alert (automatic) operating mode;

(4) Simple **local co-ordination logics** between KKVs, e.g. when deployed in clusters for back-up purposes, can also be added. It has been shown that "**swarm**" behavior is based on minimal co- ordination procedures. Similarly, BEE-KKVs "swarms" can be provided with simple co-ordination rules, e.g. FIFO (first in first out) LIFO (last in first out), **CIFO** (closest in first out), with the decision and co-ordination rules designed to optimize intercepts within the SWARM CIRCLE. Designation(s) as to which swarms KKVs are assigned to - if any - could be varied.

(5) The system will also be able to **individually activate specific KKVs**, if and when so desired. More complex decision layers can be overlaid, but will not be necessary, for more discriminating operations.

(6) The **intercept circles will overlap**, but the minimax decision mode will assure the interception of the closest missile by the closest KKV. In some cases two KKVs will intercept the same missile, but better twice 'dead' than one live nuclear missile.

(7) The programmed 'intercept' distances can be varied through updates from CCC: in the **initial** phases of deployment the KKVs will be deployed at relatively **higher altitudes**, with larger intercept 'circles' and longer intercept distances.

(8)With **increasing deployment** of KKVs, say from 1000 to 5000, the newly deployed KKVs will be at **lower orbits**, with smaller intercept circles and distances. It may not be cost effective to lower the initial KKVs, in which case overlap occurs. Or the initial KKVs can be reprogrammed for higher altitude intercepts, or back- up intercepts.

(9) "**Depleted** " KKVs can be replaced in wartime by individually launched KKVs, or supplemented by **"swarms" launched on demand**, and KKV **"hives" parked in standby orbits** for KKV replacements in space to fill any gaps created by enemy actions .

(10) The KKVs can be '**gravity gradient' stabilized**, with no need for continuous 'pinpoint' accuracy before ignition, with the detection system designed so as to be able to operate within its 'circle' with the attitude accuracies given.

(11) A **two-dimensional "bee-type" intercept logic** ("target, change of target over time within circle") may allow KKVs **without any 'location' knowledge**, alleviating the need for GPS or onboard positioning systems or knowledge. (Bees home in with a minimum of information: increase or decrease in measured parameter).

To-date the key obstacles to the consideration of such highly dispersed systems are the very high energy requirements for attitude control, orbit maintenance, data processing - IFF THE TOTAL SYSTEM HAS TO BE OPTIMIZED AND CENTRALLY CO-ORDINATED.

But just as bee-colonies - and 'markets' - work by each individual optimizing SOLELY within his 'circle' of concerns, so should a highly dispersed KKV system. To allow such decentralization of decision making with **'local' optimization**, the power requirements for KKVs and their subsystems need to be minimized. Power requirements are minimized, when the system is inactive.

Ideally, the system should be **inactive most of the time**, without losing any of its ability to intercept. This is achieved with a "**Negative Gate**" CCC design.

III. The 'NEGATIVE GATE' & HIBERNATION Approaches.

To alleviate the high power requirements - and other resulting systems requirements - from the decentralization of the detection and decision function to each KKV, in the BEE-KKVs approach the tables are simply turned by having the KKVs turned OFF in a non- crisis situation (most, if not all of the time), and turned ON in a crisis situation. The OFF state is similar to the state of hibernation, wherein a few, low energy functions are continued, while most parts of the system are off, to conserve energy and assure longevity.

A crisis situation may be the detection of one single unannounced - or unauthorized - missile launch; or can be initiated by a presidential decision; etc.

The ON-OFF decision is controlled by communications beams from Geo - or any other CCC platform: as long as KKVs are 'illuminated' by these beams, the KKVs within the beams are OFF; when outside a covering beam the KKVs are automatically on.

Worldwide at most three simple communication satellites are needed, with multiple beams, so as to allow global coverage and the efficient 'regional' activation of KKVs, e.g. in the case of rogue missile attacks, mini-missile states of the 1990s, etc.

The more beams on the communications platform, the more detailed the management

capabilities for the system.

The same CCC platforms should also house any **early warning detection systems**, and other co-ordinating and household functions, since these CCC platforms now become dearly beholden to the adversary: any interference, destruction etc. of these platforms will lead to the automatic activation of all KKVs within the region, the exact opposite of the effects desired.

Override logics can be build into the KKVs for 'friendly' missiles.

CCC back-up systems should be in place in Space and on the ground.

Communications security - e.g. against enemy signals to de- activate the KKVs becomes paramount. This, however, can easily be assured by a variety of techniques. In the worst case optical (laser) communications to each KKV will assure security of override.

Please note: a 'negative gate' CCC structure only works with a high entropy (autonomous, dispersed) KKV system. Garages require a variety of more complex co-ordinating functions from and with other platforms, and hence are open to vulnerability when active.

Also, with KKVs aggregated the random distances to the likely enemy targets to be intercepted are vastly increased (for similar numbers of KKVs deployed.

IV. Effectiveness of BEE-KKV System.

Given the simplicity of the design, and the operations philosophy, a High Entropy BEE-KKVs approach will assure early deployment capability at minimum cost and high assurance of success:

The basic systems components are not dissimilar from a "STINGER" missile;

With the deployment of 10,000 dispersed KKVs

* intercept distances are **minimized** (150 to 200 miles max),
* detection capabilities **maximized**,
* intercept probabilities approach KKV reliability **(95%**, 99% ?),
* co-ordination requirements are minimized (only between the KKVs of a given "swarm" and its operations circle).

Countermeasures are few, if any:

* the 'fast burn' option, much vaunted by critics, would be of minimal value in case of the highly dispersed system, since any one missile launch - from wherever worldwide - is likely to be within 150 miles or less of a KKV, with the enemy missile in fact approaching the interceptor **during ascent** on a rather deterministic trajectory, with little or no evasive capability.

* the system is indifferent to **fixed or mobile** ICBM threats;

* **multiple warheads**, or decoys, are **not yet an issue (during ascent phase)**, with decoys to 'missile' launches readily discriminated.

* loss of one interceptor means losing **1/10,000th** of the capacity, rather than 1/100th or more;

* clustering of launches can be countered with supplemental **BEE SWARMS** from standby, in-orbit hives, or by launches on demand, to saturate certain regions;

* the simple KKVs may be impervious to **EMP and 'blinding' effects:** the KKVs are OFF unless the CCC beam is OFF. This allows for extremely effective battle management (with narrow spot beams);

* kinetic intercept methods are inapplicable to this design approach. Each individual KKV has an **extremely small cross- section,** there are 10,000+ of these objects, no central nodes of any magnitude exist or are required, and the number of "kinetic primitives" required would deny access to space by the enemy power in peace-time and assure destruction of their own ICBMs in war-time, a truly self-defeating "countermeasure";

* **disposal** of KKVs after 'useful' life (hopefully unused) can be simple vertical launch toward designated ground areas (also useful as tests of the system).

* The first unit costs may be several million dollars. A Phase I (technology demonstration) development could be achieved for a **TOTAL RDT&E cost of about $1 billion**). The average costs for the KKVs with a production of 10,000 units may be at or below $1million, for a total cost of $10 billion (a full boost phase intercept capability!);

* The **deployment costs** of the KKVs - through "BEEHIVE" launches of, say, 100 each can be minimized and are easily affordable even with existing ELV launch vehicles capable of multiple deployment (e.g. 19 deployments from one Titan launch were achieved over a decade ago); total deployment costs of 10,000 KKVs can be less than $10 billion even when using Titan IVs (say 100 KKVs per launch);

* The deterrent effect against "**third country**" ballistic missile threats (India, Pakistan, Libya, Iran, etc.) is achieved even with the initial deployment of, say, 100 KKVs, the number of interceptor missiles allowed under the ABM treaty;

* **Replenishment** of KKVs can occur '**on demand'** in case of 'depletion': one Titan or HLV launch could deploy up to 100 additional KKVs, or 10 launches could assure 1000 additional KKVs, dispersed as desired. Replenishment 'hives' could also be pre-deployed in Space.

* **Navy launched** BEE SWARM KKV capabilities are also possible to 'augment' or 'supplement' any deployed space capabilities. These could be particularly effective in regional defense situations;

* parts of the BEE-KKV technology will prove useful also in **regional defense applications**

against ballistic missile threats.

* If desired, BEE-KKVs can make use of more sophisticated CCC capabilities - and battle management assets, to be used also for intermediate and terminal defense capabilities. However, while these capabilities are clearly feasible (and more attractive than e.g. terminal defenses only as proposed by MAD advocates), these additional uses of BEE-KKVs are not essential to their main mission and role: the boost-phase intercept of nuclear ICBMs IMMEDIATELY AFTER LAUNCH.

V. CONCLUSIONS.

The proposed system is well within the reach of US Space systems technology TODAY, the costs are easily estimated and exceedingly low when compared to other system cost figures usually associated with SDI, and with additional technological advances and optimization the effectiveness of the system may well approach 100% at easily affordable costs.

No new launch systems capabilities - or other technology advances are required. 100 or 200 BEE-KKVs can be deployed for about $1 billion. This is less than the cost of one random 1 Megaton nuclear missile impact anywhere over the Continental United States. The Nitze criterion of cost effectiveness "at the margin" - or wherever else - is clearly met.