LA-UR-

Title: APPROACHES TO PRECISION DECOYS

Author(s): Gregory H. Canavan, P-DO

For discussions outside the Laboratory

Submitted to:

Date: February 28, 2001

Los Alamos
NATIONAL LABORATORY

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the U.S. Department of Energy under contract W-7405-ENG-36. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. The Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy.

Approaches to Precision Decoys

G. Canavan

Radar and infrared (IR) sensors have demonstrated their effectiveness against light traffic decoys, but there are few reliable discriminants for precision decoys in the 25 kg range, which can have credible radar and IR signatures. However, such decoys are limited in number by the $\approx 50\%$ fraction of a 1,000 kg payload that can be devoted to counter measures to about $500 \text{ kg} / 25 \text{ kg/decoy} \approx 20$ precision decoys/RV. Such decoys present a serious challenge to current $\approx 80 \text{ kg}$ GBIs, which have a mass exchange ratio of about $25 \text{ kg} / 80 \text{ kg} \approx 0.3$ per decoy, or $\approx 1,000 \text{ kg} / 20 \times 80 \text{ kg} \approx 0.6$ against the total payload. If slightly lighter decoys were credible or heavier GBIs were needed, the resulting mass exchange ratios would be unacceptable.

Cost exchange ratios are more difficult to estimate, as the cost and value of the threat are uncertain. If the cost of the payload is taken to be about \$1B, the exchange ratio for \$100M GBIs would be about $\$1\text{B} / (20 \times \$100\text{M}) \approx 0.5$, which is not cost effective at the margin. For robustness, it would be desirable to have an exchange ratio of 5-10:1, so a kinetic kill vehicle (KKV) about a factor of 10 lighter and cheaper than the current GBI would be needed for adequate margin. Such an advanced KKV was developed in the space based interceptor (SBI) program.

Space-based interceptors make contact with the missile in boost before it burns out. As there are no practical decoys in boost, it suffices to compare the mass and cost of the offensive and defensive elements on orbit. The DAB cost for the Brilliant Pebble (BP) is incrementally about \$1M/BP on orbit for lots of about 1,000, which gives a cost exchange ratio of about $\$1\text{B} / \$1\text{M} \approx 1,000:1$. The BP KKV weight is about 2.5 kg dry and 60 kg fueled for 6 km/s incremental velocity, so its mass exchange ratio is about $1,000 \text{ kg} / 60 \text{ kg} \approx 17:1$. But rogue launches are essentially from a point, so absentee ratios are 50-150, which reduces cost ratios to about 10:1 and mass exchange ratios to about 0.2:1. Thus, the total BP mass per missile exceeds that of the payload by a factor of five, but their cost is less than that of the payload by the desired factor of 5.

Surface-based boost phase can reach missiles before burnout and deployment of decoys for launches from certain areas. If the interceptor has the $\approx \$100\text{M}$ cost of the GBI and the kill package the 80 kg weight of the EKV, the cost and mass exchange ratios are 10:1 and 12:1, respectively. Thus, from those areas where launch can be reached with a GBI class interceptor, cost and mass ratios appear favorable. However, interceptor velocity and acceleration, and hence weight and cost, increase rapidly for more demanding engagements, which is awkward for the sea basing probably be required for such engagements.

A variant approach is the use of a BP KKV on a GBI booster, trading reduced KKV weight for additional acceleration and velocity, which could produce a $\approx \$30\text{M}$ interceptor with a larger operational envelope, given adequate supporting search and track sensors and C2. Its cost ratio would be about $\$1\text{B} / (\$1\text{M} + \$30\text{M}) \approx 30:1$, apart from costs for platform, sensors, & C2, and its mass ratio about $1,000 \text{ kg} / 3 \text{ kg} \approx 300:1$. In addition to cost, this concept would use a relatively small interceptor that could be deployed in numbers on many launchers.

Midcourse intercept based on BP KKV's, which are as capable as EKV's of discriminating traffic decoys, would have a cost exchange ratio of $\approx \$1\text{B} / (20 \times \$30\text{M}) \approx 1.7:1$. That is low, but close to the goal for robustness. Their mass exchange ratio would be about $1,000 \text{ kg} / 3 \text{ kg} \approx 300:1$, which is more than adequate. In this configuration, the reduced KKV weight would again be used for speed and range.

A variant is to use multiple KKV's per booster. The GBI has a payload of about 80 kg. If it provides axial acceleration, the BP KKB only needs enough divert fuel to cover a threat cloud, so the BP KKV could be reduced to 4-5 kg. If so, the GBI could carry about $80 \text{ kg} / 4 \text{ kg/KKV} \approx 20 \text{ BP KKV's}$, which is about the number of precision decoys in a RV's threat cloud. The formal cost exchange ratio would be about $\$1\text{B} / \$100\text{M} \approx 10:1$. If the GBI boosters are treated as a sunk cost from the current NMD program, the incremental cost would be that for 20 KKV's, which is $\approx \$20\text{M}$, so the actual ratio would be about $\$1\text{B} / \$20\text{M} = 50:1$.

It would appear that multiple BP-derived KKV's on current boosters would provide much more robust mass and cost exchange ratios against sophisticated threats. The resulting interceptors would be small enough to be carried on planned land and sea-

based launchers. They could be treated as retrofits, although the BP KKV has been developed and tested as far as the EKV. The 2-4 kg discussed above is not the limit of reduction of the KKV payload if the threat requires further division.

Summary and conclusions. Precision decoys are a serious challenge to current midcourse systems, which have marginal exchange ratios. KKV's an order of magnitude lighter and cheaper are needed; they could be provided by developed BP KKV. SBIs have adequate cost effectiveness and global coverage. Surface-based interceptors have better economics where applicable, and BP KKV's could extend the range of modest boosters.

Midcourse presents difficult problems. Intercept is unattractive with current GBIs. The excellent sensors now available essentially take away the effectiveness of traffic decoys, but extending them to discriminate the tens of precision decoys that could accompany each RV would require a whole new level of development and expense. Advanced KKV's could add effectiveness and range. Multiple KKV's on current boosters could have excellent cost exchange ratios and coverage from a range of platforms. Rather than attempting to develop sensors that can discriminate precision decoys with near-perfect signatures, an attractive alternative is to use current sensors to discriminate the precision decoys and use multiple, advanced KKV's to kill them all.