Boost-Phase Missile Defense Debate Continues

The article by Daniel Kleppner, Frederick Lamb, and David Mosher (PHYSICS TODAY, January 2004, page 30) summarizes the results of the excellent American Physical Society study released in July 2003 on boost-phase options for national missile defense.[1] The study represents one of the most authoritative analyses to date on the subject and will enhance the quality of the public debate on missile defense for years to come. However, although I agree with many of the study's conclusions, the overall assessment is somewhat pessimistic, especially with respect to the feasibility of intercepting solid-propellant intercontinental ballistic missiles.

My analysis of airborne intercept options suggests that first-generation airborne boost-phase interceptors (ABIs) carrying 90-kg kinetic-kill vehicles should be effective against liquid-propellant ICBMs. It also suggests that second-generation ABIs with 50-kg KKVs could be effective against solid-propellant ICBMs, provided the ABIs can get within approximately 500–600 km of the ICBM launch site, which is possible for relatively small states such as North Korea.[2]

ABIs have the advantage that they can contribute to an effective theater missile defense—an important mission given the widespread proliferation of short- and medium-range ballistic missiles. In fact, ABIs are the only form of terrestrial boost-phase intercept that can be effective against very short burn-time ICBMs or short-range ballistic missiles because, if necessary, ABI launch platforms can fly over an opponent's territory. Neither ground-based nor naval-based interceptors have that option.

One should also note that ABI systems pose very little threat to the strategic nuclear forces of the five major nuclear powers; hence, they are not nearly as destabilizing as other forms of missile defense. To the extent that one takes seriously the rhetoric of sharing US ballistic missile defense technology, ABI systems can be transferred because they do not threaten US or allied strategic forces.

The difference between my conclusions and those of the APS study arises from different technical assumptions that result, in my case, in greater intercept ranges. In particular, I assumed that an airborne X-band radar can be built within the next decade, which, for favorable geographies like North Korea, can reduce target-detection and tracking delays by as much as 10 to 15 seconds compared to those in the APS study. I also made the assumption,

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based on the burn times for existing US and Russian solid-propellant ICBMs, that solid-propellant ICBMs have a nominal burn time of 180 s; the APS study assumed a 170-s burn time based on US solid-propellant submarine-launched ballistic missile technology. Also, airborne missiles can accelerate faster; hence, they can have higher average flight speeds compared to surface-based interceptors (on which the APS study focused) because the drag force is lower at high altitudes.

Nevertheless, solid-propellant ICBMs are very difficult targets. Successful intercept will require sensor architectures that push the limits of target detection and tracking, and large (1500 kg), high-speed (6.0 km/s ideal velocity) two-stage airborne interceptors carrying lightweight KKVs. While 50-kg KKVs stretch the limits of what currently is possible, solid-propellant ICBMs stretch current offensive threat possibilities. Neither may be far-fetched 10 years from now.

ABIs do have drawbacks. However, none of them are so severe as to eliminate ABIs from consideration as a viable component of a future US missile defense architecture. In fact, airborne intercept is probably the most attractive boost-phase missile defense option.

Preferences regarding boost-phase ballistic missile defense often have more to do with different threat assessments, operational and political issues, and cost than with technical disagreements. I see no serious technical barrier to an effective ABI system. Nevertheless, the decision to proceed with any form of ballistic missile defense, ABIs included, should be based on an assessment of the system's priority relative to such other important US security concerns as countering terrorism and modernizing conventional forces. From this perspective, the US currently is spending too much on ballistic missile defense.

References

1. D. K. Barton et al., *Report of the APS Study Group on Boost-Phase Intercept Systems for National Missile Defense: Scientific and Technical Issues*, July 2003; available at http://www.aps.org/public_affairs/popa/reports/nmd03.cfm.
2. See D. A. Wilkening, *Science and Global Security*, (in press).

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Authors Kleppner, Lamb, and Mosher report on an excellent APS study that provides a wealth of data and analysis. Especially new are the array of possible maneuvers during the boost phase of intercontinental ballistic missiles (ICBMs) and the problems those maneuvers pose for a boost-phase intercept (BPI) system. My judgment from the report itself of the utility of BPI against North Korean ICBMs, however, is more positive than are the executive summary and press reports of the APS study.

For instance, according to an earlier PHYSICS TODAY story (September 2003, page 26), "Boost-phase missile defense . . . is virtually impossible in all but a few limited circumstances." But among those few is the most likely circumstance for ICBM attack: a liquid-fueled ICBM launched from North Korea against the continental US. I have long proposed using 14-ton interceptors based on ships or land near North Korea to defend against such an attack.[1] And I assumed the boost phase of such an ICBM to be 250 seconds, little different from the 240 s assumed by the APS study, and not the "300 s or more, as some earlier studies had [assumed]," as stated in the January 2004 PHYSICS TODAY article. The study's first conclusion, that the "interceptor rockets would have to be substantially faster (and therefore necessarily larger) than those usually proposed," refers to some people who have advocated much smaller interceptors than my 14-ton proposal.

If the US Department of Defense decided to deploy within four years a system using large surface-based interceptors against North Korean ICBMs, the US could likely expect at least several years of protection.

Necessary? Maybe not. Feasible? Yes. And that is not the end of the line for boost-phase intercept. Simple geometry shows that airborne radar at altitudes typical of modern airline jets (12 km) will see to the ground at a range of 400 km, adding important tens of seconds to the time available for intercept by a ground- or sea-based BPI system.

Reference

1. R. L. Garwin, http://fas.org/rlg/991117.htm; http://fas.org/rlg/031208-boost.pdf.

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The authors of the *Report of the APS Study Group on Boost-Phase Intercept Systems for National Missile Defense* are to be commended on the most in-depth public examination of boost-phase missile defense to date. However, their study and the PHYSICS TODAY article based on it are marred by overstatement. I particularly address the analysis of ground-based interceptors.

The study's crucial calculation of the earliest possible time to launch an interceptor appears to be flawed. The study authors claim that the defender must wait until a fairly precise track on the offensive missile has been established before launching an interceptor—that wait is a major factor in the firing delay. In a sense, that claim is true: If a defender fires its interceptor too far away from the threat missile's actual track, the interceptor will be unable to correct course and destroy the threat missile.

The defender can compensate, however, by firing multiple interceptors, each in a direction predicated on a different potential threat-missile trajectory; that option was not considered in the study. Using only a few interceptors, the defender can bracket the range of possible offensive trajectories thoroughly enough that at least one interceptor will always be able to correct course and intercept the threat missile—assuming, of course, that the threat missile can be reached in time. Thus, the defender could possibly shave 15–20 seconds off the launch delay by firing when the enemy missile is detected, rather than waiting to establish its trajectory.

The second problem with the study's launch-delay calculations, as reported in the PHYSICS TODAY article, concerns the assessment of cloud cover. The article authors, Daniel Kleppner, Frederick Lamb, and David Mosher, "assumed that a modern system would first see a bright spot when a missile reaches [7 km]." They noted that even "state-of-the-art sensors would not detect a rocket until it has risen above any dense clouds. But at mid-latitudes, dense clouds are relatively rare above 7 km." Of course, that only shows that detectors would likely see a rocket when or before it reached 7 km; a more careful analysis would have to show that 7 km is both the lower and the upper bound on detection altitude. The study does not contain such an analysis. Because the expectation of lower