

# Abstract: Space-Based Boost-Phase Interception

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The current United States midcourse interception architecture could be overwhelmed by a high-volume Intercontinental Ballistic Missile (ICBM) attack. In response, the *Iron Dome for America* initiative has renewed interest in advanced missile defense technologies to counter next-generation strategic threats. This study evaluates **space-based boost-phase interception (SBPI)** to strengthen U.S. missile defense.

Boost-phase interception offers key advantages: ICBMs emit strong thermal signatures, follow predictable trajectories, and can be destroyed before deploying multiple warheads. However, the short engagement window forces ground- and air-based systems to operate near hostile territory. Space-based interceptors enable early engagement without needing forward-positioned systems.

This research develops an optimization framework using an integer linear program (ILP) to design constellations that minimize the number of satellites while maximizing “worst-case” lethality across potential launch locations. Performance is evaluated using standardized metrics for interceptor efficiency, geographic coverage equity, and system robustness, enabling comparison across interceptor velocities and salvo capacities.

A large-scale design of experiments examines tradeoffs across regions, missile classes, and target densities. Preliminary results show that interceptor speed is a critical initial constraint but exhibits diminishing returns beyond a threshold. Moreover, increased salvo capacity does not significantly reduce required constellation density; thus, lower-capacity architectures achieve comparable coverage with fewer interceptors. Overall, medium-speed, low-capacity configurations perform most effectively.

Optimal constellations favor heterogeneous designs, with orbital inclinations aligned to adversary launch latitudes to maximize revisit rates and higher altitudes to expand coverage despite increased response time. Results suggest that effective SBPI architecture is driven more by interceptor placement and distribution than by maximizing interceptor velocity or salvo capacity.

