CONGRESSIONAL BUDGET OFFICE
U.S. Congress
Washington, DC 20515

Phillip L. Swagel, Director

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Honorable Deb Fischer
Chair
Subcommittee on Strategic Forces
Committee on Armed Services
United States Senate
Washington, DC 20510

Honorable Angus S. King Jr.
Ranking Member
Subcommittee on Strategic Forces
Committee on Armed Services
United States Senate
Washington, DC 20510

Re: Effects of Lower Launch Costs on Previous Estimates for Space-Based, Boost-Phase Missile Defense

Dear Senators:

As you requested, this letter provides the Congressional Budget Office's estimates of how recent declines in the costs of launch services would change previous estimates of the costs to deploy a constellation of space-based interceptors (SBIs) designed to defeat one or two intercontinental ballistic missiles (ICBMs) fired at the United States by a regional adversary, such as North Korea. Those previous estimates appeared in studies published by CBO in 2004 and by the National Research Council (NRC) in 2012.[1] Although launch costs are lower now, threats and U.S. policies have changed since those studies were published in ways that could increase the overall size and cost of an SBI constellation.

By themselves, decreases in launch costs could reduce the previous estimates of the 20-year costs of various SBI constellations by 30 percent to 40 percent, CBO finds. For the lowest-cost alternative that CBO examines here, the reduction in launch costs would cause the total estimated cost of deploying and operating the SBI constellation for 20 years to fall from $264 billion to $161 billion (in 2025 dollars). For the highest-cost

[1] Congressional Budget Office, *Alternatives for Boost-Phase Missile Defense* (July 2004), www.cbo.gov/publication/15852; and National Research Council, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives* (National Academies Press, 2012), https://doi.org/10.17226/13189.

alternative that CBO examines, the total estimate would fall from $831 billion to $542 billion. (The wide range of estimates among the alternatives, both before and after accounting for the reduction in launch costs, results from differing assumptions about the performance of the individual components that make up the SBI constellations.)

Although launch costs are much lower today than when the previous studies were published, two major factors could lead to higher costs for space-based missile defenses than CBO and the NRC estimated earlier. First, North Korea's ICBMs have increased in number and sophistication since those studies were published. Second, a recent executive order by the President, titled *The Iron Dome for America*, calls for deploying a missile defense system to protect the United States not only from attacks by regional adversaries (ones with limited capabilities, such as North Korea) but also from attacks by peer or near-peer adversaries (ones with military capabilities similar to those of the United States).[2] Such a defense could require a more expansive SBI capability than the systems examined in the previous studies. Quantifying those recent changes will require further analysis, which CBO is undertaking at your request.

Effects of Launch Costs on the Estimated Costs of Boost-Phase SBI Constellations

Concepts for constellations of space-based interceptors in low-Earth orbit have been proposed since the Strategic Defense Initiative of the 1980s. Such a system has not been fielded, however—at least partly because of the high cost to launch the hundreds or thousands of SBIs that would be needed to provide even a minimal defense against incoming missiles. Today's lower launch costs might make SBIs a more attractive option for U.S. missile defense.

In this letter, CBO applies updated launch costs to estimates from the 2004 CBO study and the 2012 NRC study of the composition and costs of space-based systems designed to intercept ICBMs aimed at the United States. Those studies analyzed various alternatives, including space-based defenses capable of intercepting ICBMs during their boost phase—the three to five minutes at the beginning of an ICBM's trajectory when the missile's rocket motor is still burning. The estimated costs for several alternatives—Option 4 in the CBO study and the comparable space-based Case 1 and

[2] Executive Office of the President, *The Iron Dome for America*, Executive Order 14186 (January 27, 2025), https://tinyurl.com/mryx7t37.

Table 1.

20-Year Costs of Three Alternative Constellations of Space-Based Interceptors

	With launch costs at time of study ($9,800 to $10,600 per pound)			With illustrative launch cost representative of today's market ($1,200 per pound)		
	CBO Option 4	NRC Case 1	NRC Case 3	CBO Option 4	NRC Case 1	NRC Case 3
Number of SBIs in constellation	1,308	1,000	2,000	1,308	1,000	2,000
Costs over 20 years (billions of 2025 dollars)						
RDT&E	11.5	5.7	5.7	11.5	5.7	5.7
Procurement						
SBIs	130.2	243.3	483.7	130.2	243.3	483.7
Launch services	116.0	168.5	335.3	13.2	23.5	47.1
Subtotal, procurement	246.2	411.8	819.0	143.4	266.8	530.8
Operation and support	5.8	5.9	5.9	5.8	5.9	5.9
Total	**263.5**	**423.4**	**830.6**	**160.7**	**278.4**	**542.4**
Savings over 20 years from decreases in the costs of launch services (billions of 2025 dollars)	n.a.	n.a.	n.a.	102.8	145.0	288.2
Share of total 20-year costs (percent)						
RDT&E	4	1	1	7	2	1
Procurement of SBIs	49	57	58	81	87	89
Procurement of launch services	44	40	40	8	8	9
Operation and support	2	1	1	4	2	1

Data sources: Congressional Budget Office, *Alternatives for Boost-Phase Missile Defense* (July 2004), www.cbo.gov/publication/15852; and National Research Council, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives* (National Academies Press, 2012), https://doi.org/10.17226/13189.

The costs shown here represent the lower ends of ranges of estimated costs for the constellations analyzed in the CBO and NRC studies.

NRC = National Research Council; RDT&E = research, development, test, and evaluation; SBIs = space-based interceptors; n.a. = not applicable.

Case 3 in the NRC study—are shown in Table 1. (Both studies provided a range of potential costs for each alternative; for simplicity, CBO focuses on the lower ends of those ranges, converted to 2025 dollars, in this letter. The upper ends of the ranges were 38 percent higher in the CBO study and 69 percent higher in the NRC study than the costs shown here.)

The lower estimates in the CBO and NRC studies incorporated effective launch costs of $9,800 to $10,600 per pound of payload, which resulted in total launch costs over 20 years of $116 billion to $335 billion. The wide variation in total launch costs resulted not only from differences in launch costs per pound but also from differences in the total mass of interceptors launched. Each constellation in those analyses had a different number of SBIs and a different weight per SBI, depending on the specific design.

For example, in the NRC study, Case 3 had twice the number of SBIs and nearly twice the total cost of Case 1. That difference stemmed from differing assumptions about when interceptors could be fired. In Case 1, interceptors could be fired as soon as the launch of a missile had been detected and its initial trajectory had been estimated; in Case 3, an additional 30 seconds was assumed for assessing whether the missile posed a threat before firing the interceptors. Because the interceptors in Case 3 would be fired later—and thus have less time to reach their target—they would need to be closer together in orbit. That need doubled the number of SBIs required in the constellation from 1,000 in Case 1 to 2,000 in Case 3.

Today, launch costs for orbits like the ones used by the constellations that CBO and the NRC analyzed are roughly one-tenth the costs in the previous estimates. For the updated estimates, CBO used a representative launch cost of $1,200 per pound, which would reduce the total 20-year launch costs for the three constellations from the previous estimates of $116 billion, $169 billion, and $335 billion to $13 billion, $24 billion, and $47 billion, respectively (see Table 1). With those lower costs, launch services would account for less than 10 percent of the total costs of the constellations over 20 years, as opposed to about 40 percent in the original CBO and NRC estimates.

Launch costs of less than $1,200 per pound might be possible in today's market, especially if very large rockets, such as the SpaceX Starship, could be used. However, the number of SBIs that a launcher could carry might be limited by the interceptors' shape and volume rather than by their weight. That limitation would effectively increase launch costs per pound. Moreover, SBIs would need to be precisely located in relation to one another in different orbits, so using a larger number of smaller launchers might be a more efficient way to put interceptors into low-Earth orbit. In any event, additional reductions in launch costs would have a limited effect on lowering the overall cost of an SBI constellation further, because even at $1,200 per pound, estimated launch costs would account for less than one-tenth of a constellation's total cost.

With the previous higher launch costs per pound, minimizing weight was an important design factor for the SBI constellations examined in the CBO and NRC studies. With today's lower launch costs per pound, a heavier SBI constellation might be more cost-effective if its greater launch costs could be more than offset by lower costs to procure interceptors. Further analysis would be necessary to explore that possibility.

Other Factors That Could Change the Costs of SBI Constellations

In the 13 to 21 years since the NRC and CBO studies were published, the potential adversaries addressed in those studies have increased their long-range missile capabilities. In addition, the President's *Iron Dome* executive order calls for significantly expanding the United States' missile defense capabilities to protect against attacks by peer or near-peer adversaries. That change could have significant effects on the required performance and cost of an SBI constellation.

Increases in the Capability of Regional Adversaries. The SBI constellations examined in the CBO and NRC studies were sized to counter one or two ICBMs fired by North Korea. Since those studies were published, regional powers have fielded more advanced missiles. For example, North Korea has expanded its arsenal of ICBMs, increasing the number of missiles and fielding solid-fuel missiles, which burn faster and are thus more difficult to intercept during their boost phase than liquid-fuel missiles. North Korea is probably now capable of launching attacks with enough ICBMs to overwhelm the SBI defenses examined in the CBO and NRC studies. The cost of an SBI constellation designed to counter a threat from a given country increases roughly in proportion to the size of the attack that the constellation is designed to defeat.

Expansion of the U.S. Missile Defense Mission to Include Peer Adversaries. The United States' long-standing policy has been that missile defenses capable of defeating ICBMs were intended to counter threats from regional adversaries (often referred to as "rogue adversaries" or "rogue nations"), whereas strategic nuclear forces would be relied on to deter attacks from peer or near-peer adversaries, such as China and Russia. The President's *Iron Dome* executive order, however, states that "the next generation missile defense shield" will include plans to defend against "next-generation aerial attacks from peer, near-peer, and rogue adversaries."[3] That order also calls for the "development and deployment of proliferated space-based interceptors capable of boost-phase intercept."

[3] Executive Office of the President, *The Iron Dome for America*, Executive Order 14186 (January 27, 2025), https://tinyurl.com/mryx7t37.

SBI constellations intended to counter ICBM attacks by China or Russia rather than by a less capable adversary (such as North Korea) would need to be much bigger—and therefore more costly—than the constellations in the previous studies, for several reasons:

- China and Russia have ICBM inventories in the hundreds and could easily overwhelm constellations sized to counter North Korea's smaller inventory.

- China and Russia are likely to have greater abilities than North Korea to reduce the effectiveness of an SBI constellation by using countermeasures—such as deploying boosters that burn out faster to shorten the time available for intercepts, varying boosters' thrust to complicate tracking, and directly targeting SBIs with antisatellite weapons.

- China and, especially, Russia could launch ICBMs from territory farther north than North Korea could, effectively increasing the area of Earth that would need to be covered by SBIs. Covering that larger area would require having more SBIs in orbits with higher inclinations than assumed in the earlier CBO and NRC studies. (Inclination measures how far north and south of the equator the orbital path of a satellite reaches.)[4]

In response to the President's order, the Department of Defense could opt to pursue missile defenses that used SBIs to counter threats from rogue adversaries and used other systems to counter threats from peer and near-peer adversaries. If so, the SBI system would probably have to be larger than those assumed in the two earlier studies—because of increases in North Korea's capabilities—but not as large as would be necessary to counter Chinese or Russian attacks. The specific role that SBIs are intended to play in the Administration's plans may be defined in the "reference missile defense architecture" that the Secretary of Defense has been directed to submit to the President.

[4] For more information about how the latitude of the area intended to be covered by SBIs affects the size of the constellation, see Congressional Budget Office, *Alternatives for Boost-Phase Missile Defense* (July 2004), pp. 17–18, www.cbo.gov/publication/15852.

I hope you find this information helpful. Please contact me if you have further questions.

Sincerely,

Phillip L. Swagel
Director

cc: Honorable Roger F. Wicker
Chairman
Senate Committee on Armed Services

Honorable Jack Reed
Ranking Member

Honorable Mike Rogers
Chairman
House Committee on Armed Services

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