Sustaining the U.S. Nuclear Deterrent: the LRSO and GBSD

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Overview

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- **Why this report?**
- **Factors that should shape future requirements for the U.S. triad**
- **ALCM modernization and the LRSO**
- **Minuteman III modernization and the GBSD**
- **Summary**

Background

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- **The U.S. triad consists of long-range bombers that carry nuclear gravity weapons and cruise missiles, ICBMs, and SSBNs**

- **All DoD Nuclear Posture Reviews since the Cold Wars (NPR 1994, 2001, 2010, 2018) supported the need to maintain a strong and credible triad**
  - However, multiple major triad modernization programs have been truncated (such as the B-2 and Advanced Cruise Missile programs), delayed (ICBM replacement), or cancelled (previous stealth bomber program)

- **Russia and China are aggressively modernizing their nuclear forces**

- **Russia has violated the 1987 INF Treaty, China's nuclear inventory is not constrained by an arms control agreement**

- **The proliferation of missile and other technologies enabled North Korea to fast-track its development of nuclear weapons; Iran continues to develop relevant capabilities**

A Cold War-era force

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1954 Chevy Bel Air

1970 Ford Pinto

1984 Ford Escort

1962 Ford Fusion

1980 Oldsmobile Cutlass

1993 Ford Probe

1950s | 1960s | 1970s | 1980s | 1990s | 2000s

B-52

Delivered 1954 - 1962

Minuteman Silos

First built in 1962

ALCM

Delivered 1980 - 1986

Minuteman III

Delivered 1970 - 1977

B-1B

Delivered 1984 – 1988
(now conventional only)

B-2

Delivered
1993 - 2000

Funding for DoD's Strategic Forces
(Major Force Program-1)

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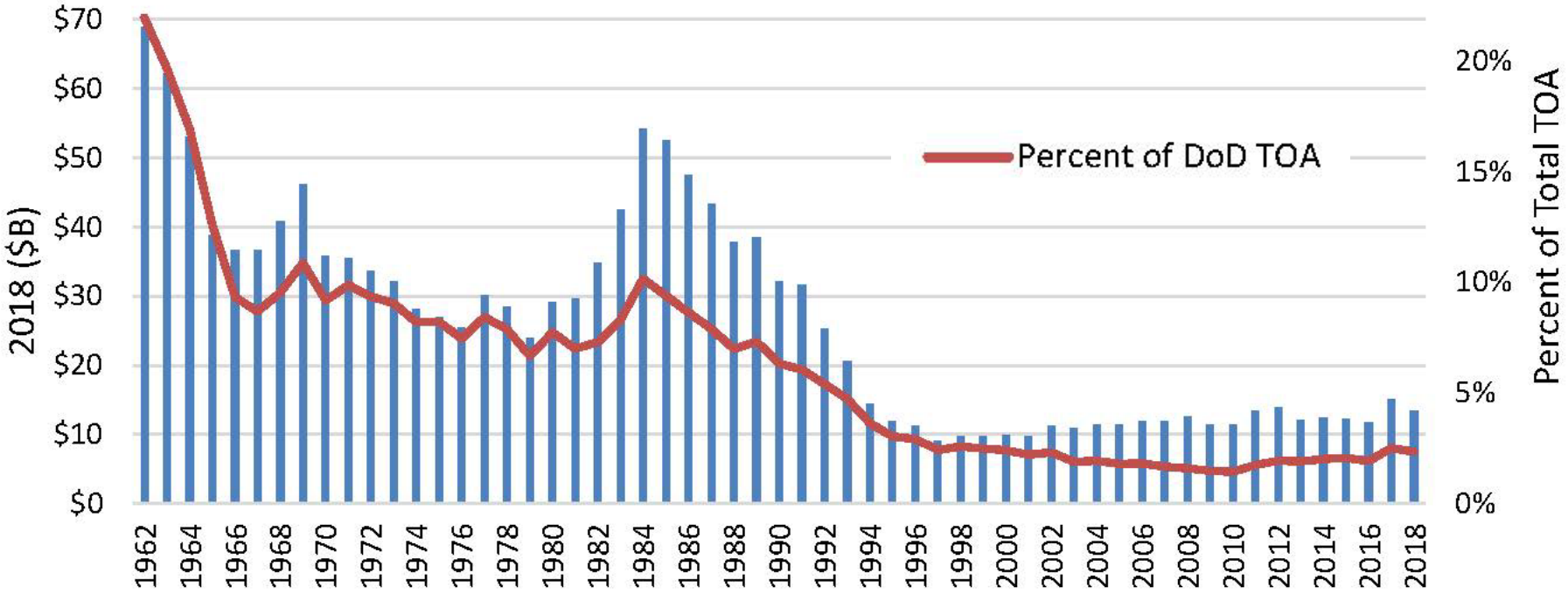
- **FY1962: About 22% of DoD's TOA ($68.9B in FY2018 dollars)**
- **FY1962 to end of Cold War: Averaged 9.6% of annual TOA ($38.6B in FY2018 dollars)**
- **FY1992 to FY2017: Averaged 2.4% of annual TOA ($12.6B in FY2018 dollars)**
  - FY2010 was the nadir at 1.4% of TOA
  - 2016-2017 jumped from 1.9% to 2.5% of TOA, largest increase since 1983-1984
  - Little force modernization



U.S. triad under New START

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Undersea forces

- 14 *Ohio*-class SSBNs (2 in overhaul)
  - 240 deployed launchers (20 per boat) with Trident II D5 SLBMs (MIRV)
  - 280 deployed and non-deployed launchers, 1,090 total warheads
- *Columbia*-class SSBNs IOC in early 2030s

Bomber forces

- 20 total B-2s, carry B61 and B83 nuclear gravity bombs
- 75 total B-52Hs, 47 are nuclear capable
  - Nuclear gravity bombs, AGM-86 ALCMs, LRSO IOC late 2020s
- Nuclear-capable B-21s begin to join the force in mid-2020s, nuclear gravity bombs and future LRSO

All B-1s have been modified for conventional only missions

Land-based missile forces

- 400 Minuteman III missiles in “deployed” silo launchers
  - 50 non-deployed launchers and 4 test launchers
  - All have single warheads, limited capability to re-MIRV
- GBSD IOC circa 2029, FOC 2036, single warhead but MIRV-capable

SSBNs

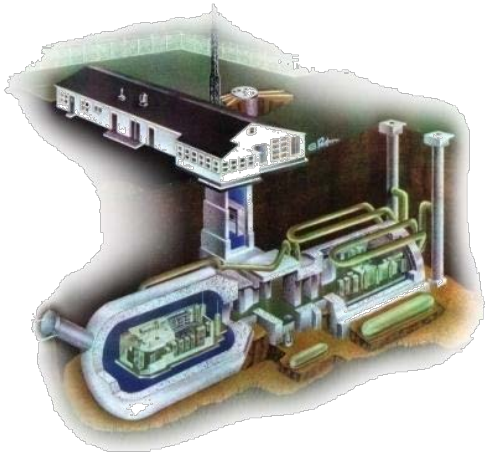
- Most survivable leg of the triad, essential to maintaining a secure second-strike capability
- Deployed SSBNs difficult to locate and preemptively attack
- Comprise about 70% of U.S. deployed strategic forces as defined by New START counting rules
- W76 and W88 warheads facilitate both counterforce and countervalue targeting
- Rapid, unforeseen advances in ASW technology could increase vulnerability

ICBMs

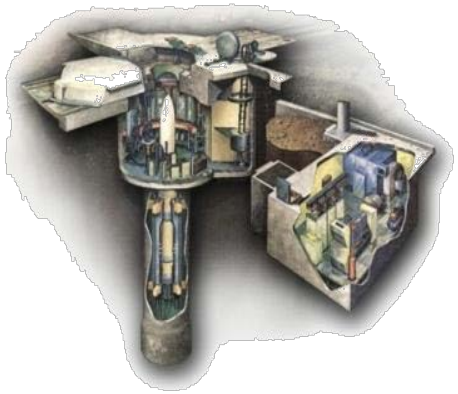
- Highly responsive – about 99 percent of missiles are on constant alert
- Redundant command and control networks
- Provide the ability to execute a scalable retaliatory strike
- An enemy seeking to significantly degrade the triad would have to launch a massive strike against the U.S. homeland-based ICBM force – this greatly increases the threshold for nuclear aggression

Silo-based Missiles

Launch Control Centers



Launch Facilities



Air-breathing leg of the triad

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Offers flexible employment options that SSBNs and ICBMs do not

- **Bombers provide a highly visible means to send signals in crises**
  - Can generate the force to alert status, disperse to other locations including overseas bases, etc.
- **Once generated, bombers are survivable and can be launched and then recalled**
- **Flight paths can circumvent sensitive territory**
- **A bomber force can attack targets from multiple azimuths**
- **Bombers can perform conventional operations and non-combat missions (e.g., participate in exercises with allies, conduct global power demonstrations)**

Key study recommendations

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- **A flexible, adaptable, & credible triad is needed to sustain strategic deterrence**
- **DoD should plan for multipolar great power competition**
  - DoD's force development planning should prioritize concepts and capabilities for long-term competition with Russia and China
  - China's nuclear capabilities should not be considered as a "lesser included case"
- **DoD should assess capabilities that will be effective in increasingly contested future threat environments**
  - Applies to future triad requirements as well as conventional forces and capabilities
- **Replace the AGM-86B Air Launched Cruise Missile**
  - Fully resource the LRSO program to replace ALCMs as planned
  - Assess potential for LRSO to support extended deterrence
- **Replace the Minuteman III and its infrastructure**
  - Fully resource the GBSD program to replace the Minuteman III force as planned
  - Design the GBSD to hedge against uncertainty
- **Take advantage of triad modernization programs to help revitalize the U.S. defense industrial base**

Shaping Future Triad Requirements

Russia's triad modernization

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Project 955A *Borei II*-class SSBN

Undersea forces

- Includes 3 *Delta II*, 6 *Delta IV*, 3 *Borei*-class SSBNs (16 SLBMs)
  - Declining oil revenues may slow blue water navy modernization, funding stream for its SSBN modernization plans is stable
- Fielding 8 new *Borei II*-class boats by 2020s with capacity to carry additional warheads
- Also developing a nuclear torpedo with intercontinental range

Tu-160M2 Blackjack Bomber

Bomber forces

- About 120 total, about 50 count toward treaty heavy bomber limits
- Plan to sustain Tu-160 (Blackjack) and Tu-95MS (Bear H) to 2030
- New nuclear-capable stealth bomber, IOC by mid-2020s?
- New Kh-102 nuclear-capable cruise missile, new supersonic and hypersonic cruise missiles

RS-28 "Sarmat" ICBM

Strategic Rocket Forces ballistic missiles

- 3 missile armies, 12 divs, 40 regts; 300 ICBMS with 1,000 warheads; over 50% Soviet-era ICBMs were modernized by 2015, rest by early 2020s
- All mobile ICBMs MIRVed by early 2020, will give Russia the ability to quickly increase its numbers of operational warheads
- RS-28 Sarmat ICBM (the "country killer") will deploy circa 2020
  - 10-16 RVs with capabilities to evade defenses; possibly 24 hypersonic glide vehicles (HGVs) capable of evading known defenses

China's nuclear forces modernization

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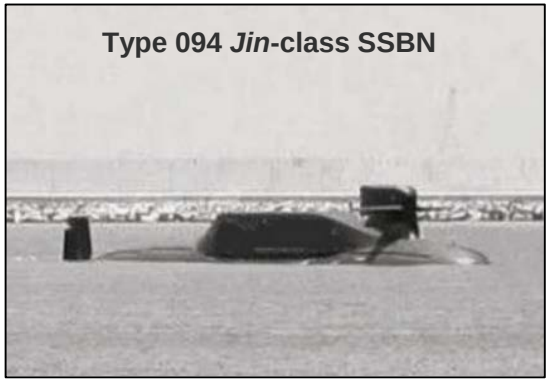
Type 094 *Jin*-class SSBN

Undersea forces

- Operates 4 (soon 5) Type 094 *Jin*-class SSBNs, carry JL–2 SLBMs with max range of 8,000 km (MIRVs? or single warhead)
  - Provides China with "the ability to conduct a nuclear strike from the sea and, perhaps more importantly…a survivable second strike capability"
- Will invest in a next-gen Type 096 SSBN and a new JL-3 SLBM


Future Y-20U refueling a H-6N

Bomber forces

- Unclear if PLAAF & PLAN H-6 bombers deliver nukes
  - Some analysts believe some H-6 intermediate range bombers (20 H-6s) may have a secondary nuclear mission
  - Developing "H-X" (H-20) stealth bomber, likely nuclear capable
- CJ-20 long-range CM nuclear/conventional (AFGSC)


DF-41 ICBM on a TEL

PLA Rocket Force ballistic and cruise missiles

- About 150 land-based nuclear ballistic missiles, 50-75 ICBMs
  - New DF-31AG ICBM road mobile and MIRV capable
  - New DF-41 ICBM silo-based, road- and rail-mobile, 6 to10 MIRVs
- Programs may give China a significantly larger, more capable nuclear missile inventory; some variants may soon carry HGVs

Future threat environment: China's and Russia's maturing air and missile defenses

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Advanced SAMs

- Both are modernizing their SAMs; China first S-400 in January 2018, Russia reorganizing to improve effectiveness of its air defenses
- Relocatable, networked, increasingly capable against aircraft and missiles
- Both are proliferators

Missile defenses

- China's BMD is closely linked to its ASAT program; tested hit-to-kill weapon in 2018
- Russia's S-500 and other systems will give it a layered BMD system by 2020
- Both have increasingly capable active and passive cruise missile defenses

Underground facilities (UGFs)

- China is continuing its massive UGF building program
- Russia has reinvigorated its Cold War UGFs and is building more

Increasingly integrated, overlapping, and redundant air and missile defenses

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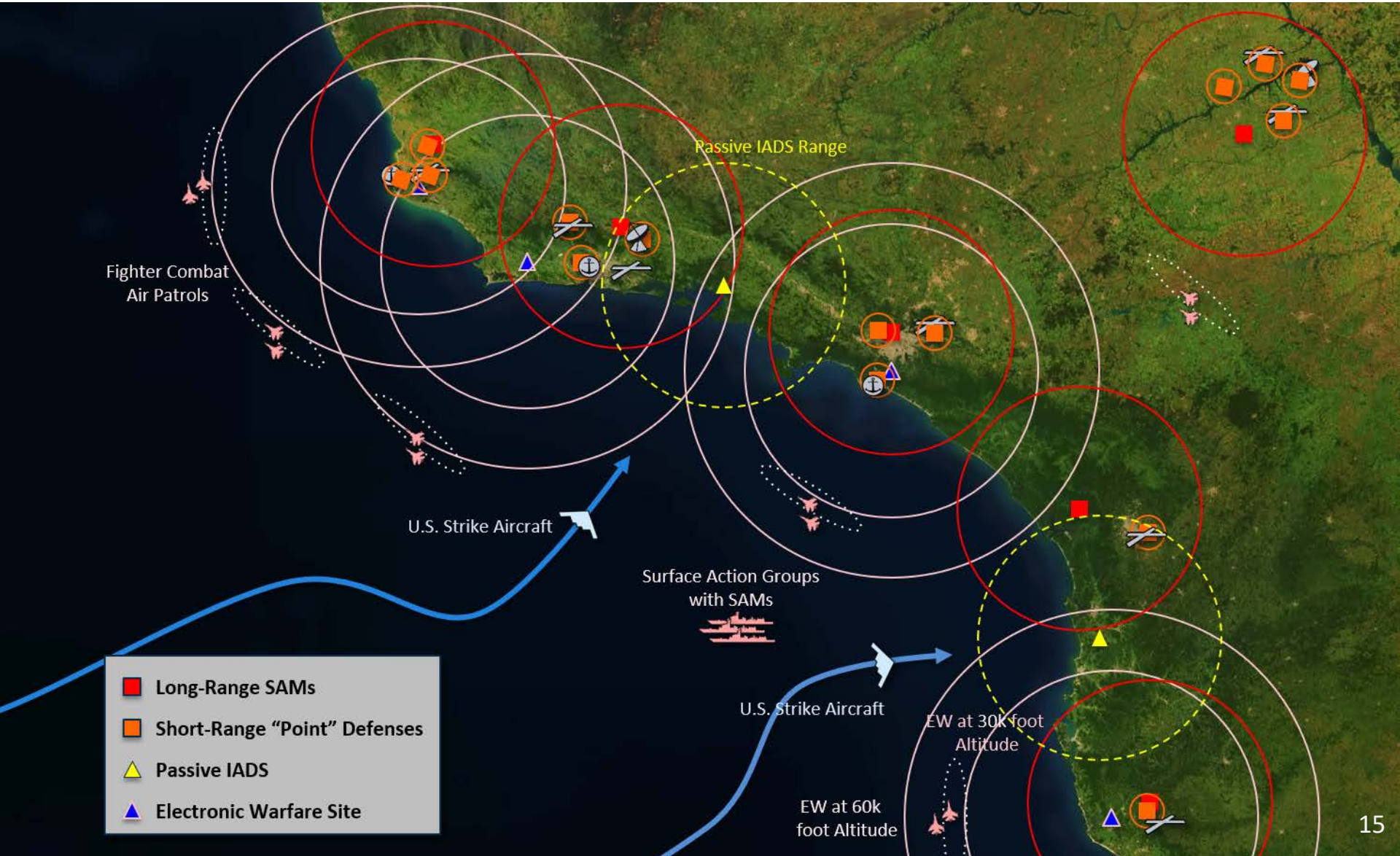
Increasingly capable against individual weapons, not just aircraft



ALCM Modernization

AGM-86B ALCM

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Overview

- Long-range (more than 1,500 nm), subsonic, single warhead cruise missile
  - Only nuclear cruise missile now in the U.S. inventory
  - Conventional "CALCM" AGM-86C/D variants
- Designed in the mid-1970s with a planned 10 year service life, life extension programs will keep ALCMs in the inventory until approximately 2030
- A bomber force capable of conducting standoff and penetrating attacks greatly complicates a competitor's defensive challenges
  - An all standoff-strike force would permit adversaries to optimize their defenses to defeat cruise and ballistic missiles

Concerns: The ALCM's future reliability, availability, and effectiveness

- Numerous reliability issues that life extension programs may not be able to fully address
- May be pressed to meet availability requirements toward the end of its service life
  - Periodic testing and other attrition could reduce ALCM inventory below number needed to fully load-out all remaining nuclear-capable B-52s
- Ability of subsonic, non-stealth cruise missiles to penetrate advanced missile defenses

Long Range Standoff (LRSO) missile

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Description

- LRSOs will begin to replace AGM-86B ALCMs in the 2030 timeframe
  - DoD is procuring the weapon, DOE has responsibility for the W80-4 warhead Life Extension Program
- Will be able to penetrate advanced IADS, operate in GPS-denied environments, and hold high value targets at risk from significant standoff ranges
- Nuclear-capable B-52Hs and B-21s will carry LRSOs; today, only nuclear-capable B-52Hs carry ALCMs

Typical arguments made against the LRSO

- Cruise missiles are “destabilizing”
- The LRSO will be a “redundant” capability
- The LRSO will be “too expensive”

Cruise missiles are "destabilizing"

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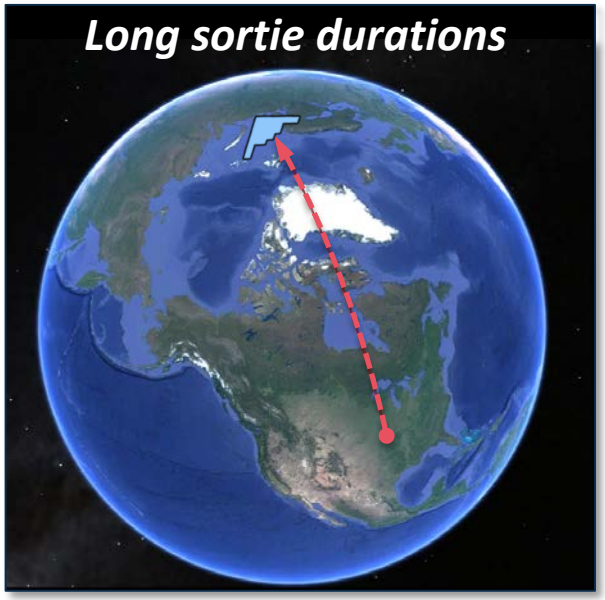
- **There is little evidence that cruise missiles were destabilizing during the Cold War**
- **Bombers with cruise missiles and gravity weapons may be the *most* stabilizing element of the U.S. triad**
  - Visible means to send signals in crises; for instance, can generate bombers to alert status and disperse the force to other locations
  - Bombers have longer flight times relative to ballistic missiles and can be recalled after launch
  - Cruise missiles can be withheld or retargeted
- **China's and Russia's acquisition of modern, dual-capable air-launched cruise missiles suggest they may not share this concern**



LRSOs will be "redundant"

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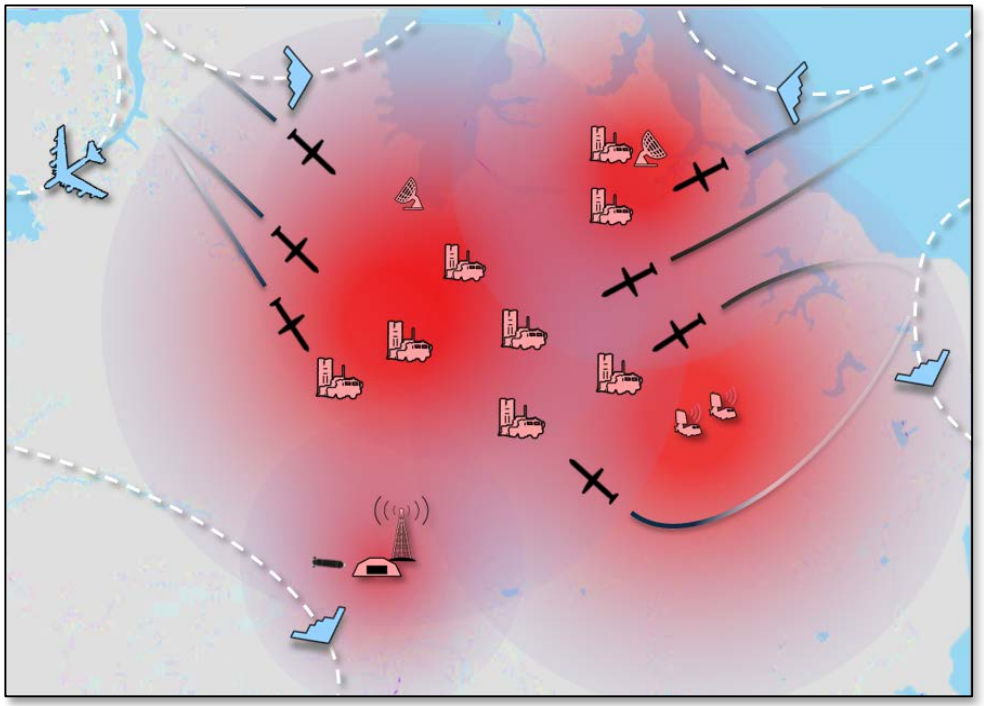
- **Cruise missiles help enable attacks from multiple azimuths**
- **Penetrating bombers and cruise missiles impose costs**
- **LRSOs will give non-stealth B-52Hs (in the force until 2050) the ability to attack targets while staying outside contested areas**
- **LRSOs will *complement* stealth bombers**
  - Some standoff may be needed to avoid highest threat areas located close to some high-value targets



- **LRSOs could support extended deterrence**
  - Provide a possible limited response option that avoids using manned aircraft to penetrate enemy airspace or launching a nuclear weapon from CONUS or an SSBN

LRSO program will be "too expensive"

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LRSO Program Cost Estimates

	Missile Cost Estimate	W-80-4 LEP Nuclear Warhead	Total Estimated Cost
2016 Acquisition Decision Memorandum	$9.7 B for about 1,000 missiles	NNSA bears cost	$9.7 B for missiles only
National Nuclear Security Administration		$7 B to $10 B for 500 warheads	$7 B to $10 B for nuclear warheads
Congressional Research Service	$10.8 B		$10.8 B for missiles only
Congressional Budget Office	$13 B	$7 B to $10 B	$23 B for missiles and warheads

- Program will cost a fraction of the $94 billion the Pentagon projected it will spend on the triad from FY2016 to FY2020 (0.06 percent of DoD's total projected spending over same period)

Comparison

Missile Type (Quantity Procured)	Program Base Year	Then Year $	FY2018 $	PAUC $
ALCM (1,765 missiles)	1977	$4.1 B	$13.64 B	$7.7 M
ACM (460 missiles)	1983	$3.8 B	$8.23 B	$17.9 M
LRSO (about 1,000 missiles)	2016	$9.7 B	$8.27 B	$8.1 M

- LRSO's Program Acquisition Unit Cost (PAUC) is consistent with the ALCM's PAUC and lower than the Advanced Cruise Missile's PAUC (due in part to the ACM's truncated production run)

Minuteman III Modernization

Minuteman III ICBM

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Overview

- Three-stage, solid-fuel, silo-based ICBM
  - Only land-based component of the triad
  - Maximum 13,000 km (about 8,000 mile) range
- Upgraded from Minuteman I and II, first delivered in 1970 with a planned service life of 10 years
  - Series of programs upgraded/refurbished its propellant, guidance set, re-entry vehicle, and extended its service life substantially
  - Will remain operationally deployed through mid-2030s
- Originally 3 warheads per missile, downloaded to 1 warhead (NPR 2010)

Concerns: Future reliability, availability, and effectiveness

- Number of components will age out over the next decade and cannot be further extended or easily replaced
- Periodic test launches over the remaining lifespan will reduce inventory available to meet operationally deployed requirements

Ground Based Strategic Deterrent

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Description

- Integrated system, including launch control facilities, and C2 infrastructure
  - Air Force intends to purchase approximately 640 missiles to meet operationally deployed ICBM requirements
  - Program will also refurbish associated infrastructure, reuse 450 existing launch facilities and 45 Launch Control Centers in lieu of new construction
- Modular systems architecture will facilitate design flexibility and upgrades over time as technology and threat environments evolve
- IOC expected in late-2020s, FOC in mid-2030s, remain in the force until 2070s

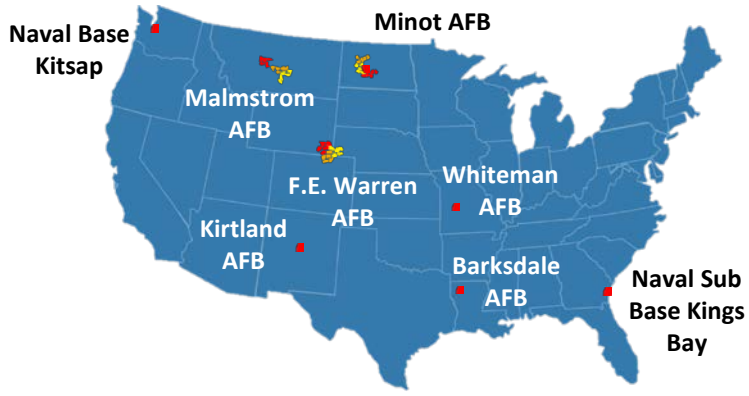
Typical arguments made against the GBSD

- ICBMs are no longer survivable/are not a credible deterrent, so Minuteman IIIs should not be replaced
- The Minuteman III force can be further extended
- The GBSD program will be too expensive

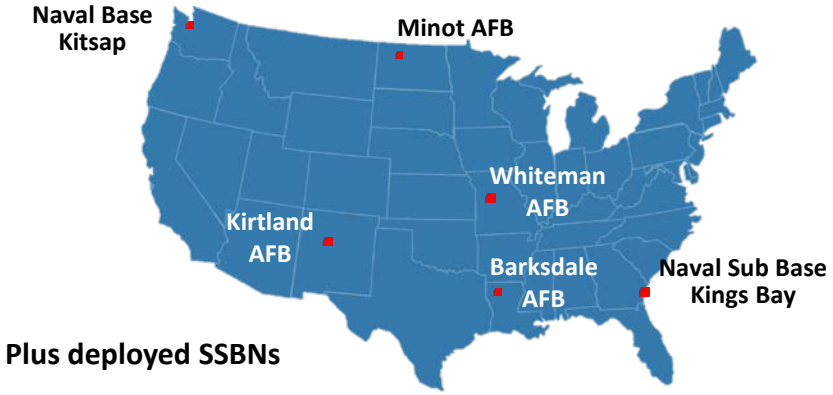
ICBMs "have lost their value as a deterrent"

- **The Minuteman III force is dispersed across a very large area**
- **It is also a "missile sink" – an enemy attempting a first strike would have to expend a very large number of warheads against Minuteman III silos and launch facilities**
  - An attacker would likely have to allocate one to two warheads per target
  - Only Russia now has a sizable enough nuclear force for such a massive attack
  - Greatly increases the threshold for nuclear aggression

With ICBMs, 500+ CONUS triad targets



Without ICBMs, 6 CONUS triad targets



Minuteman IIIs "can be further extended"

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Major Minuteman III life extension/modification programs

Program Name/Type	Completed or Planned Completion	Approximate Cost (Then Year $)	Longevity of SLEP
Propulsion System Rocket Engine Program (PSRE)	Completed 2013	$0.2 B	2027
Propulsion Replacement Program (PRP)	Completed 2013	$2.1 B	2028
Guidance Replacement Program (GRP)	Completed 2009	$1.8 B	2032
Rapid Execution and Combat Targeting (REACT) Service Life Extension Program	Completed 2006	$0.2 B	Not available
Safety Enhanced Reentry Vehicle (SERV)	Completed 2012	$0.4 B	Not available
Miscellaneous small programs	Unknown	$2.3 B	Not available
Subtotal for first wave of SLEPs		**$7.0 B**	
Solid Rock Motor Warm Line Program	Only funded in 2013	$76.9 M	Not applicable
ICBM Fuze Modernization for Minuteman III and GBSD	Ongoing, 2027	$410.2 M spent $1.64 B to complete	2060
ICBM Demonstration/Validation Program for Minuteman III and GBSD	Ongoing	$252.3 M through FY17, final TBD	Not applicable

Critical MM III components will age out

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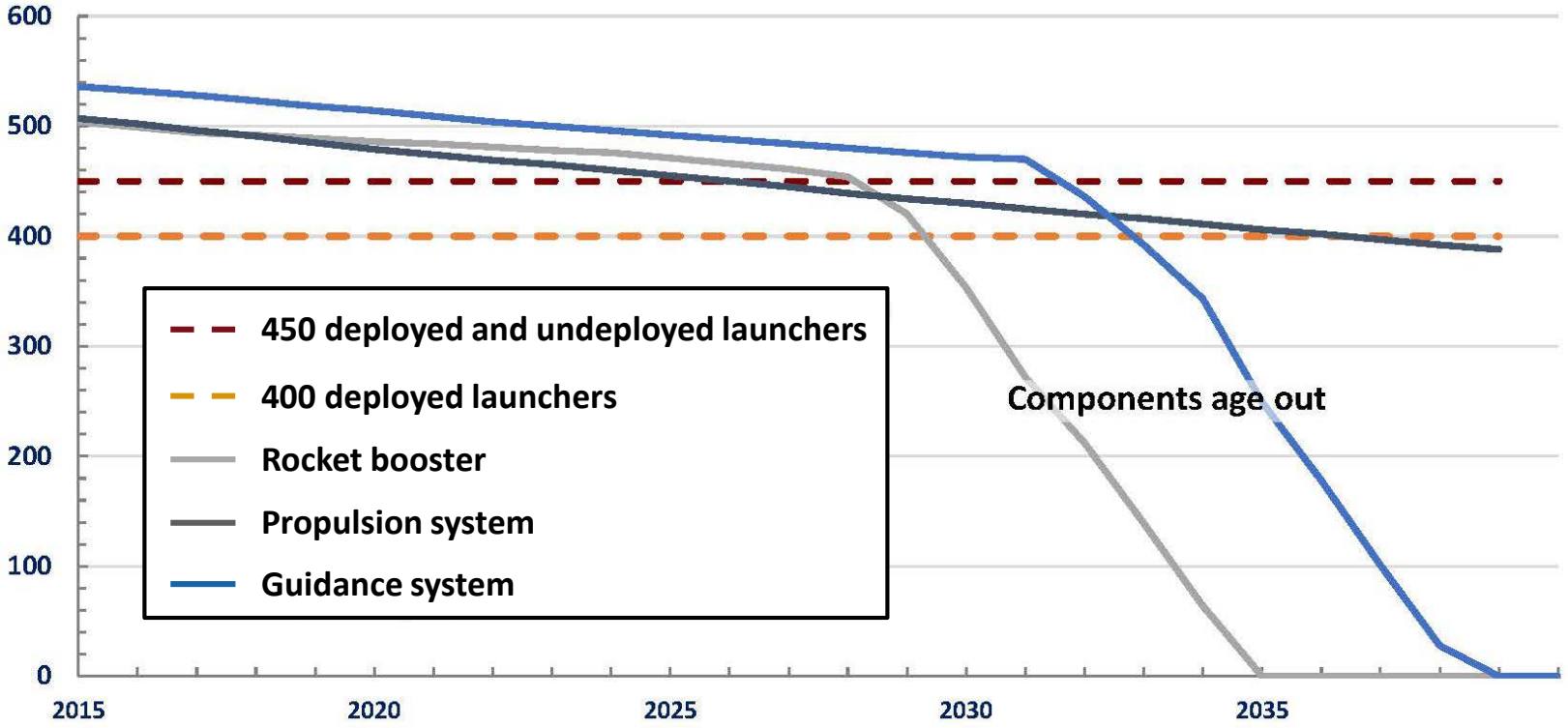
Projected decrease in MM III missiles due to aging components



- **Inability to upgrade or repair some major components will reduce inventory available to support deployed force**
- **Another issue: annual required testing will also reduce inventory**
  - Less testing not desirable given the need to assess viability of aging MM III

The GBSD will be "too expensive"

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GBSD Program Cost Estimates

Source	ICBM	C2	Infrastructure	Total Cost
Air Force estimate (in 2015)	$48.5 B $700 M for TMRR $15 B for EMD $32 B procurement	$6.9 B	$6.9 B	$62.3 B
OSD/Office of Cost Assessment and Program Evaluation	—	—	—	$85 B to $100 B

- The Air Force estimate was largely based on data extrapolated from previous ICBM programs; the GBSD program is taking advantage of mature technologies to reduce cost
- OSD/CAPE estimate based in part on data from MDA programs such as the Ground-based Midcourse Defense, which is technologically more challenging and likely required more new development compared to GBSD

Estimated Total Cost FY2016-2075

Option	Notes	Total Cost (FY14 $)
Minuteman III SLEP	"Maintaining and extending the life of a system that does not meet capability goals eliminated it as a final candidate solution"	$160.3 B
GBSD in modernized MM III launch facilities		$159.2 B

- Although the estimated cost of both options through FY2075 is about the same, DoD has said only the GBSD will meet its future requirements

Summary

Modernizing the air-breathing leg of the triad

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- **A failure to modernize the U.S. nuclear-capable bomber force—including its weapons—would erode the triad's credibility**
- **Funded life extension programs will keep ALCMs in the force until approximately 2030**
  - However, it's unlikely that life extension programs focused on ALCM availability and sustainability issues significantly improved its ability to penetrate future threat environments
- **Without a standoff attack weapon capable of penetrating future air defenses, non-stealth B-52Hs that now make up the majority of the nuclear-capable bomber force will not able to strike targets in contested areas**
- **As air defenses continue to improve, even stealth platforms may need to launch attacks against some targets from standoff distances that exceed the very short ranges of gravity bombs**

Minuteman III and the GBSD

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- **DoD has funded multiple programs to upgrade and sustain its Minuteman IIIs beyond their original ten-year planned service life**
- **Despite these programs, there are critical MM III capabilities that cannot be sustained much past 2030**
  - Electronics updated by the completed Guidance Replacement Program begin to age out in 2032
  - Issues related to extending MM III solid rocket motors are so significant that they undercut the viability of doing so
- **Component age-out is a major reason why DoD has requested funding to develop and field a Minuteman III replacement**
  - Component age-out and required testing will eventually reduce the size of the U.S. ICBM force below minimum operational requirements
- **Cost over time of sustaining the Minuteman III compared to a GBSD force is essentially a wash**
  - However, the Minuteman III will not meet future requirements





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