Berkeley Public Policy The Goldman School

# Nuclear Risk in an Era of Strategic Competition

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## **Brief Introduction**

I am a scholar of international relations working at the intersection of technology, politics, and international security issues.

**Research:** Nuclear weapons, AI governance, cybersecurity, civ-mil relations, political methodology and wargaming

CSIS

**Teaching:** War? Emerging Tech and National Security Policy; Nuclear Security; Intro to Technology and Public Policy; Quantitative Methods

#### Affiliations (selected):

- Founder, Berkeley Risk and Security Lab
- Director, Center for Security in Politics
- Director, Bridging the Gap



COUNCILon FOREIGN RELATIONS









### Agenda

- 1. Context: The Three Body Problem
- 2. Nuclear Force Postures
  - a. Today
  - b. And Tomorrow (Nuclear Modernization)

#### 3. \*Contemporary **Debates**

- a. Nuclear Numbers
- b. Targeting
- c. Non-strategic Weapons
- d. MD/Hypersonics
- e. Al
- f. The Future of Arms Control





#### The "Three Body Problem"







### **Nuclear Modernization in Russia**

Approx. 1,500 deployed nuclear warheads (per the "old" New START limits)

+ Approx. 2,000 non-strategic nuclear weapons

#### Developing new capabilities:

- Sarmat Heavy ICBM (MIRV-ed)
- 9M730 Burevestnik (nuclear-armed/powered)
- Avangard HGV
  - Breaking the INF Treaty
- Poseidon (Status-6) Torpedo





### **Nuclear Modernization: China**

#### Quantitative increase ("Breakout")

- The rate of this increase is subject to debate
- 300 —> 1,000 warheads (est. by 2030 by U.S. Dept. of Defense)

#### Qualitative change in force posture

- The rise of the PLA-N
- Siloes in Hami, Yumen, and Ordos

Failed attempts to engage Beijing in nuclear arms control talks







### **Developments in the DPRK**







### And Proliferation Risks in the Middle East



World ∨ Business ∨ Markets ∨ Sustainability ∨ Legal ∨ Breakingviews ∨ More ∨

### Iran undoes slowdown in enrichment of uranium to near weapons-grade -IAEA

#### By Francois Murphy

December 26, 2023 4:44 AM PST - Updated a month ago



The Iranian flag flutters in front of the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and a state of the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 2022. DELITED II and the International Atomic Energy Agency (IAEA) organisation's headquarters in Vienna, Austria, June 5, 202









### **Two U.S. Nuclear Posture Documents**

#### **2022 Nuclear Posture Review**

- Identifies Russia, China, North Korea, and Iran as potential nuclear challenges, focuses on China as a pacing threat;
- 2. Reasserts U.S. commitments to **nuclear arms control**;
- 3. Cancels SLCM-N, retires B83-1 Gravity Bomb, and prioritizes plutonium **pit production**;
- 4. Provides country specific strategies and heavily focuses on collaboration with **allies**.
- 5. Nuclear risk reduction and nonproliferation at the margins

#### **2023 Strategic Posture Commission Report**

- 1. Focused on Russia and China, including Russo-Chinese nuclear collaboration;
- Recommends increasing delivery systems numbers across the triad and deploying more non-strategic nuclear forces;
- Calls for active deployment of some active hedge warheads and full funding of NNSA recapitalization efforts (including **pit production**);
- 4. Recommends **increasing** and **modernizing** conventional forces.



### What are Nuclear Weapons For?

The Strategic Posture Commission Report suggests that U.S. nuclear strategy be based upon:

- Assured **second strike**
- Flexible response to achieve national objectives
- **Tailored** deterrence to hold at risk what an adversary values most
- Extended deterrence and assurance
- **Calculated ambiguity** in declaratory policy
- **Hedge** against risk (geopolitical, technical, operational, programmatic)



### U.S. "Nuclear Triad"

#### Air Based

46 B-52 Stratofortress (carrying up to 20 GM-86B cruise missiles) and 20 B-2A Spirit bombers (carrying up to 16 B61-7 or B61-11 gravity bombs) \*F-15E, F-16C/D, and F-35 carry non-strategic B61 gravity bomb

#### Land Based

400 Minuteman III ICBMs in hardened silos, each carrying a W87/Mk21 or W78/Mk12A warhead





#### Sea Based

14 Ohio Class submarines, each with up to 20 Trident II D5 SLBMs carrying 4-5 W-76-1, W76-2, or W-88 warheads



# Table 1. First deployment of nuclear delivery systemsand the end of original design lives

Current System	Year First Deployed	End of Original Design Life
MMIII ICBM	1970	1980
B-2A Bomber	1997	None
B-52H Bomber	1961	1981
AGM-86B ALCM	1982	1992
Ohio-class SSBN	1981	2011
Trident II D5	1990	2015
Trident D5LE	2017	2042
F-15E DCA	1988	None



### **\*From Triad to Dyad?**

There has been a long-standing debate as to whether the ICBM leg of the triad is redundant

While others suggest that the bomber leg should be abandoned

Either way, the Air Force isn't happy...

#### **3 REASONS WHY THE U.S. DOESN'T NEED ICBMs**

#### They're **technologically** redundant





#### • They cost a lot







ARMS CONTROL AND NON-PROLIFERATION



## The Role of the Triad

**Survivability.** Ensuring second-strike stability (SSBN via difficulty of detection and ICBM via intercontinental range)

**Responsiveness.** ICBMs can be launched within minutes and reach target in approx. 30 minutes

**Flexibility.** Signaling applications (e.g., FONOPs using the air leg)

Coupling. DCAs

Positive Control. NC3 and "Always, Never"



# Nuclear Modernization in the United States

Modernizing the "triad"

- Staying within **New START** limits
  - 1,550 warheads
  - 700 deployed missiles and bombers
    - 800 total (incl. non-deployed)

# As well as modernizing **C4ISR** and **NC3** capabilities



Figure 1. Illustration of the like-for-like transition from legacy to modernized systems.<sup>212</sup>



### **Progress Report: Nuclear Modernization**

Modernization of **all three** legs have run into problems—with subsequent calls to:

- "Extend" the life of Ohio-class
- "Uploading" ICBM and SLBM warheads
- "Re-convert" SLBM launchers and B-52 bombers



Time

Figure 3: Notional depiction of the transition from a nuclear triad based on legacy systems to triad based on modern systems in the event of a POR delay (or combination of delays). In this case, the total inventory, illustrated by the red dashed line, would experience a shortfall in the late 2020s through early 2030s.



### \*The U.S. Nuclear Enterprise

The U.S. Department of Defense is not responsible for the production of nuclear weapons, that falls to the the U.S. Department of Energy and the National Nuclear Security Administration (DOE/NNSA).

How is it going?



Sources: GAO presentation of National Nuclear Security Administration Information; Map Resources (map). | GAO-23-104402



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#### Asset Condition by Replacement Plant Value %

Building Condition Index for operating buildings and trailers and Laboratory Operating Board scores for other structures and facilities



Figure 4. NNSA Asset condition by replacement plant value percentage240

How is it going?



#### \*Is More Better?

While official doctrine has remained **unchanged**, there are increasing calls among some for a quantitative and qualitative **increase** in the number and type of nuclear forces...





#### FOREIGN AFFAIRS

#### \*Is More Better?

While official doctrine has remained unchanged, there are increasing calls among conservatives for a quantitative and qualitative increase in the number and type of nuclear forces...

#### The U.S. Nuclear Arsenal Can Deter Both China and Russia

#### Why America Doesn't Need More Missiles

By Charles L. Glaser, James M. Acton, and Steve Fetter October 5, 2023



Posing with nuclear missiles in Beijing, October 2022 Florence Lo / Reuters



#### FOREIGN AFFAIRS

#### \*Nuclear "Uses"

Under what conditions would states use nuclear weapons?

- In response to adversary nuclear use?
- In response to adversary attack with "strategic effects"
- For warfighting?

#### The Return of Nuclear Escalation

How America's Adversaries Have Hijacked Its Old Deterrence Strategy

By Keir A. Lieber and Daryl G. Press November/December 2023

Published on October 24, 2023



Joan Wong



## \*Nuclear Targeting

Should the US maintain its current nuclear targeting policy of holding at risk China's and Russia's leaders, nuclear command-and-control capabilities, military forces, and war supporting industry (WSI), or should it shift to an approach that focuses on conventional forces and WSI?



https://www.csis.org/events/poni-liv e-debate-us-nuclear-targeting

Vocab: Counterforce vs. Countervalue targeting



## **\*Whither SLCM-N?**

#### **SLCM-N and non-strategic weapons**

- Cancelled in the 2022 Nuclear Posture Review.
- Included in the 2023 NDAA

SPC report encourages "increased deployment" of non-strategic nuclear weapons (particularly in Europe and the Indo-Pacific).



THE DISCRIMINATION PROBLEM: WHY PUTTING LOW-YIELD 9:43 NUCLEAR WEAPONS ON SUBMARINES IS SO DANGEROUS

VIPIN NARANG FEBRUARY 8, 2018 COMMENTARY







### **\*Whither SLCM-N?**

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#### DISCRIMINATION DETAILS MATTER: CLARIFYING AN ARGUMENT ABOUT LOW-YIELD NUCLEAR WARHEADS

AUSTIN LONG FEBRUARY 16, 2018 COMMENTARY





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A note on wargaming...



#### **\*Whither Missile Defense?**





The GMD system involves a complex, global network of components. The launch of the threat missile (1) is detected by forward-based radars, if present, and satellite-based infrared sensors (2). The threat missile releases its warhead and decoys (in this example the decoys are balloons, and a balloon contains the warhead; together they are referred to as the "threat cloud") (3), and the ground-based radar begins tracking the threat cloud (4). Based on information from this radar, the GMD system launches one or more interceptors (5), each of which releases a kill vehicle (6). If a discrimination radar, such as the Sea Based X-band Radar, is in place it will observe the threat cloud to try to determine which object is the warhead (7) and pass this information to the kill vehicle. The kill vehicle also observes the threat cloud to attempt to determine which object is the warhead (8). It then steers itself into the path of the chosen object and attempts to destroy it with the force of impact (9).

© Union of Concerned Scientists



## \*Hypersonic Weapons

Hypersonic denotes a speech of greater than Mach 5

- Glide vehicles
- Scramjet vehicles

# What are the key characteristics of a hypersonic weapon?

What are the missions for the weapon?



The approximate speed and trajectory, in pink, of a hypersonic glide vehicle weapon, which is boosted into the air and then glides at high speeds to its target, compared with a non-hypersonic cruise missile and a ballistic missile.

> Hypersonic Missiles Are Game-Changers, and America Doesn't Have Them



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#### Machine Learning & **Pattern Recognition**



Vs.

\*"The AI"

Al applications that are worthy of our attention tend to be the more mundane...





MYKEL J. KOCHENDERFER TIM A. WHEELER KYLE H. WRAY



31



### \*Machine Learning and AI-NC3 Integration

There are three clear intersections between ML capabilities and nuclear weapons:

- Signal/Anomaly detection (early warning)
- Dynamic (Re-)Targeting
- Decision support
  - "Left of launch" operations (prediction)

With consequences for...

• Conflict timelines; Uncertainty (particularly in cases of **data poisoning**)







#### **Thanks!**

#### areddie@berkeley.edu; brsl.berkeley.edu



#### The End of Arms Control?

#### Linton F. Brooks

For almost half a century, the United States and the Soviet Union/Russian Federation have used arms control treaties to help regulate their nuclear relationship. The current such agreement, the 2011 New START treaty, expires in 2021, although the signatories can extend it until 2026. Because of mutual mistrust and incompatible positions on what to include in a follow-on agreement, New START will probably expire without a replacement. This essay examines the reasons for the demise of treaty-based arms control, reviews what will actually be lost by such a demise, and suggests some mitigation measures. It argues for a broader conception of arms control to include all forms of cooperative risk reduction and proposes new measures to prevent inadvertent escalation in crises.

#### Not so fast...



### \*The Future of Arms Control

It is unlikely that the **strategic imperatives** behind arms control will disappear, though it may look different moving forward...

- Nuclear limits *sans* verification
- Nuclear risk reduction and nonproliferation at the margins
- Al governance and confidence building measures

#### U.S., Russia Agree to Call for Negotiating New START Successor

#### ARMS CONTROL NOW

Authored by Shannon Bugos and Heather Foye on September 8, 2022

The United States and Russia committed to a statement expressing the need for the world's two largest nuclearweapon states to negotiate a follow-on arms control arrangement to the 2010 New Strategic Arms Reduction Treaty (New START), which expires in under four years. This commitment came during the monthlong 10<sup>th</sup> review conference for the 1968 nuclear Nonproliferation Treaty (NPT) held in August, at which U.S. President Joe Biden stated that his administration stands prepared to begin such arms control talks.

"The Russian Federation and the United States commit to the full implementation of the New START Treaty and





# National Security in an Uncertain World Dr. Kimberly S. Budil Director, Lawrence Livermore National Laboratory



4:00 - 6:00 pm

Banatao Auditorium Sutardja Dai Hall







https://bit.ly/BRSLFeb



## "Offset Strategies"

For the United States, nuclear weapons represent a key way in which technological development allows for substitution of capability and "**offset strategies**"

- First Offset (1950s)
- Second Offset (1970s and 1980s)
- Third Offset (2010s)
  - Robotics, artificial intelligence, miniaturization





#### Notes

- What are the drivers of US nuclear policy, and what has changed / is changing?

- How do developments in Russia, China, and DPRK affect things?

- What are some misconceptions about US policy and the policies of other countries?
- In what ways will technological change affect nuclear risk?

- What can we learn from wargames and simulations? Can they help us prepare better? Improve decision making in a crisis? Under what circumstances might we think of wargames as experiments that have broader validity? How does this field intersect with forecasting?

- How concerned should we be about the intersection of AI and nuclear, both in the US and other countries?
- For people interested in careers in this field, what skills, competencies, experiences, and networks should they seek to build?
- What role do academic organizations and NGOs play? (He can talk here about the Berkeley risk lab he founded)



# **The Future of Arms Control**



#### **The Arms Control Puzzle**

Why do states that compete with one another—arming proxies, stealing IP, and engaging in gray zone warfare—create agreements that curtail their ability to proliferate weapons that might help them prevail in a conflict?

Secondarily, why develop and then limit military technologies?





### My Answer

It has less to do with the normative or **moral** concerns...

# ... and more to do with **strategic benefits**

- Cooperative arms control
- Competitive arms control

And this is good news...



Thomas C. Schelling Morton H. Halperin

A Pergamon-Brassey's Classic



## **A Working Definition**

"...all the forms of military cooperation between potential enemies in the interest of reducing the likelihood of war, its scope and violence if it occurs, and the political and economic costs of being prepared for it." (Schelling and Halperin)

More specifically, agreements at the **international** level to limit or control the **development**, **production**, **stockpiling**, **proliferation** and **usage** of specific **technologies** with **military applications**.

- Importantly, this definition is expansive—beyond the nuclear, treaty-based arms control examples that come to mind (e.g., SALT, START, etc.)
- \*\*Note: Does not require that the regime be subject to monitoring and verification



# A (Very) Brief History of Arms Control (1)

Arms control regimes focused on the **disarmament** of those defeated in war

• From the Rome-Carthage Treaty of 201BC to the 1919 Treaty of Versailles

And also on the "rules of war"

- In the 1000s: Poitiers, Limoge, and other towns where the Catholic church proscribed violence temporally-and one specific classes of people
- 1139: Canon 29 of the Second Lateran Council prohibits the use of crossbows on Christians
- Canon 71 of the Fourth Lateran Council prohibits the sale of weapons to the non-Christian Saracens (yes, this is export control)



### A (Very) Brief History of Arms Control (2)

And to "control" strategic competition among states

Washington Naval Treaty of 1922 limits naval construction, asymmetrically



PHOTOGRAPH MADE IN THE AUDITORIUM OF MEMORIAL CONTINENTIAL HALL ON NOVEMBER 12, 1921, AT THE OPFNING SESSION OF THE CONFERENCE ON THE LIMITATION OF ARMAMENT, SHOWING SECRETARY OF STATE HUGHES JUST BEFORE READING HIS MESSAGE TO THE WORLDS' LEADERS SEATED ABOUT THE SQUARE TABLE IN THE FOREGROUND ARE M. VIVIANI AND M. BRIAND. FACING THE CAMERA ARE LEFT TO RIGHT, SENATOR OSCAR UNDERWOOD, HON, ELIHU ROOT, LODGE, SECRETARY HUGHES, MR. BALFOUR, LORD LEE OF FAREHAM AND SIR AUKLAND GEDDES. IN THE BACKGROUND CAN BE DISTINGUISHED SAMUEL GOMPERS, GENERAL PERSHING, THEODORE ROOSEVELT AND HERBERT HOOVER

Tonnage limitations					
Country	Capital ships	Aircraft carriers			
British Empire	525,000 tons (533,000 tonnes)	135,000 tons (137,000 tonnes)			
United States	525,000 tons (533,000 tonnes)	135,000 tons (137,000 tonnes)			
Empire of Japan	315,000 tons (320,000 tonnes)	81,000 tons (82,000 tonnes)			
France	175,000 tons (178,000 tonnes)	60,000 tons (61,000 tonnes)			
Italy	175,000 tons (178,000 tonnes)	60,000 tons (61,000 tonnes)			



# A (Very) Brief History of Arms Control (3)

Unique fears associated with the advent of the nuclear age led to multilateral efforts to "control" the proliferation of weapons of mass destruction:

- Baruch Plan of 1946
- Limited Test Ban Treaty of 1963
- Nuclear Nonproliferation Treaty of 1968 (entered into force in 1970)
  - Formation of the IAEA
  - Made permanent in 1995
- Biological Weapons Convention of 1972 (entered into force in 1975)
- Chemical Weapons Convention of 1993 (entered into force in 1997)





# A (Very) Brief History of Arms Control (3)

And associated efforts to prevent the sharing of technologies across borders, referred to as **export control**:

- Coordinating Committee for Multilateral Export Controls, CoCom (1949)
- Zangger Committee/Nuclear Suppliers Group (founded in 1971; NSG in 1974)
- Missile Technology Control Regime of 1987
- Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies of 1996

\*\*In the United States over the past five years, CFIUS/FIRRMA and sanctions policy as tools of economic statecraft particularly pronounced.



# A (Very) Brief History of Arms Control (4)

Alongside these multilateral regimes, the United States and USSR (and then Russia) negotiated a series of bilateral, nuclear arms control agreements (\*some of which became multilateral following the fall of the USSR)

• These agreements varied in terms of their design—most notably in terms of their monitoring and verification arrangements

There were also nuclear-adjacent agreements, most notably the Anti-Ballistic Missile (ABM) Treaty 1972–2002 and CFE.





- Take the basic question, how do you maximize your security?
- Do you want **more** quantitative or qualitative capability at your fingertips or **less**?





- But, your adversary feels exactly the same way...
- This is where we get concerned about a **security dilemma** and associated "arms racing" behavior.
  - Arguably, increasing the likelihood of conflict...
- Thus, a state pursuing its national security imperatives is reducing stability at the level of the international system (e.g., BMD)

SYSTEM	
STATE	
GROUP	
INDIVIDUAL	



- Thus, it might make sense for adversaries to cooperate to seek **mutual stability** 
  - Seeking arrangements that allow for the "avoidance of war that neither side wants" (Schelling)
  - In practice, reducing the advantage of a state going first ("first strike stability") and creating the conditions that allow for punishment ("second strike stability")
- This becomes particularly important given classes of weapons with existential consequences-where inadvertent escalation would have devastating consequences
- Arms control sought to solve this problem
  - $\circ$  NTM, data exchanges, inspections, verification regimes



Arms control also offered ancillary benefits

- Reduction in military spending that might have otherwise occurred
- Opportunities to pursue "competitive arms control" (Maurer)
  - Where states negotiate to benefit themselves
    - This might explain why states pursue technologies that it may not use as a bargaining chip (SLCM-N; hypersonics)



**3 Phases of Arms Control:** Negotiation; Agreement; Practice



#### The End of Arms Control?

#### Linton F. Brooks

For almost half a century, the United States and the Soviet Union/Russian Federation have used arms control treaties to help regulate their nuclear relationship. The current such agreement, the 2011 New START treaty, expires in 2021, although the signatories can extend it until 2026. Because of mutual mistrust and incompatible positions on what to include in a follow-on agreement, New START will probably expire without a replacement. This essay examines the reasons for the demise of treaty-based arms control, reviews what will actually be lost by such a demise, and suggests some mitigation measures. It argues for a broader conception of arms control to include all forms of cooperative risk reduction and proposes new measures to prevent inadvertent escalation in crises.

#### Not so fast...



### The Future of Arms Control

It is unlikely that the strategic imperatives behind arms control will disappear, though it may look different moving forward...

- Nuclear limits sans verification
- Nuclear risk reduction
- Al governance and confidence building measures

#### U.S., Russia Agree to Call for Negotiating New START Successor

#### ARMS CONTROL NOW

Authored by Shannon Bugos and Heather Foye on September 8, 2022

The United States and Russia committed to a statement expressing the need for the world's two largest nuclearweapon states to negotiate a follow-on arms control arrangement to the 2010 New Strategic Arms Reduction Treaty (New START), which expires in under four years. This commitment came during the monthlong 10<sup>th</sup> review conference for the 1968 nuclear Nonproliferation Treaty (NPT) held in August, at which U.S. President Joe Biden stated that his administration stands prepared to begin such arms control talks.

"The Russian Federation and the United States commit to the full implementation of the New START Treaty and





### **The Future of Arms Control**

#### What comes after 2026?

- Qualitative and quantitative shifts in nuclear force postures
- Long-term disagreements
  - Missile Defense
  - Non-Strategic Nuclear
    Weapons

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"The Russian Federation and the United States commit to the full implementation of the New START Treaty and to pursue negotiations in good faith on a successor framework to New START before its expiration in 2026, in order to achieve deeper, irreversible, and verifiable reductions in their nuclear arsenals," states the final draft document of the NPT conference.



### Why We Care About Arms Control Today...

And **who** is going to be involved in the negotiations?



#### 2021 ESTIMATED GLOBAL NUCLEAR WARHEAD INVENTORIES

The world's nuclear-armed states possess a combined total of nearly 13,080 nuclear warheads; more than 90% belong to Russia and the United States. Approximately 9,600 warheads are in military service, with the rest awaiting dismantlement.





#### **\*AI-NC3 Integration**

Under what conditions (and with what emergent properties) do AI technologies yield stability risks?

- Signal detection
  - Data poisoning
- Decision support
  - Left-of-launch preemption





#### **Beyond "Nuclear" Arms Control**



An 'Arms Race in Speed': Hypersonic Weapons and the Changing Calculus of Battle

By Michael T. Klare





What does cyber arms control look like? Four principles for managing cyber risk

Building better security for wider Europe

GLOBAL SECURITY POLICY BRIEF

Andrew Futter June 2020



## **Today's Arms Control Pitfalls**

#### **Strained Relationships**

Increasing distrust between the U.S. and Russia, as well as between stakeholders in the U.S. in China. Lack of operational communication between the US military and the PLA alongside waning U.S. - Russia operational communication.

#### **Rhetorical and Doctrinal Opacity**

Including political divisions over doctrine in the U.S. (such as the SLCM-N debate, and highlighted be the different NPRs), unexpected Russian nuclear rhetoric, and lack of clarity about the continuance of long-standing PRC doctrine (including No First Use and warhead demating)

#### **Talent Erosion and Scarcity**

Lack of recent arms control agreements has meant less prioritization of arms control talent, and a loss of opportunities to train future arms control experts



### **Key U.S. Nuclear Posture Challenges**

- 1. **Timely Modernization:** challenges within the defense industrial base threaten the U.S.'s modernization timelines, with submarine industrial base of particular concern
- **2. Warhead production:** in particular, the U.S. government is concerned about its capability to ramp up plutonium pit production, with a goal of producing 80 pits a year.
- **3. Three Body Problem:** The U.S. faces two near peer nuclear competitors at the same time, in different theatres, holding different interests, and with different nuclear and conventional capabilities.



## **Opportunities for Arms Control**

#### Russia

- Long-standing arms control relationship with the United States, some of which remains intact
- Budget deficits and focus on rebuilding conventional forces post Ukraine
- Not all of the "doomsday suite" has worked (ex. Burevestnik), allowing for so

#### China

- 1. Seeking greater influence in international institutions
- 2. Previously rejected participating in arms control on the bases of a capabilities imbalance, which is now narrowing
- Concerned about U.S. capabilities, and might be interested in negotiating them away



### **Autonomous Systems**

Surveillance vs. "kinetic" mission sets

Human-machine integration:

- HITL
- HOTL
- HOOTL

The "Race to the bottom" and AI governance







### **Nuclear Modernization**

• Proposition: Nuclear weapons remain central to the future of war—particularly among great powers...

One of our great fears is that emerging technologies make the practice of deterrence more difficult

> Effects on survivability... and thus mutual vulnerability that underpins deterrence



