

**MITCHELL INSTITUTE**  
for Aerospace Studies



**Maneuver Warfare in Space:  
The Strategic Imperative for  
Nuclear Propulsion**

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# The threat: China and Russia seek to gain a decisive warfighting advantage in space

- Both are developing military space forces that will be capable of conducting maneuver warfare in space
- China's space maneuver warfare forces will include vehicles with nuclear propulsion that are capable of rapidly transferring between Earth orbits and in cis-lunar space
  - This would give China the capability to rapidly maneuver between operational earth orbits and out to cislunar space as needed for deterrence and warfighting advantage.





# Advantages and limitations of our current satellite constellation architectures

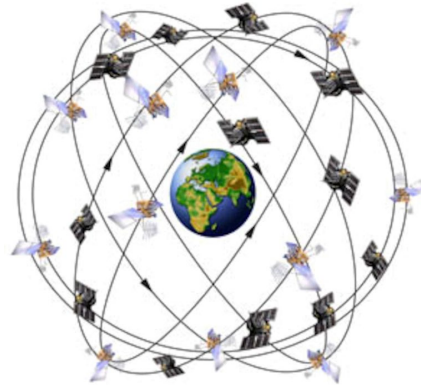
## Advantages:

- Global perspective
- Freedom of overflight
- Mission persistence

## Limitations:

- **Vulnerable** to non-kinetic and kinetic attacks in, from, and to space
- Operate in legacy, monolithic constellations or proliferated constructs-operate in orbits that are **predictable and can be tracked** by adversaries that have even a basic space tracking network
- Current satellite constellations **have limited maneuver capacity for defensive actions** such as avoiding kinetic or non-kinetic attacks

GPS Constellation



**The problem: U.S. space forces are not ready for China's enhanced space maneuver warfare threat**



# We must maintain our strategic and operational advantages in space

- The current view is to rely upon a more resilient, proliferated LEO constellation concept-these are just as vulnerable to attack
- The USSF must adopt a new force design that includes satellites and with nuclear propulsion capable of decisive maneuver warfighting advantages from, to, and in space
- Space nuclear propulsion (SNP) will expedite DOD's transition from its dependency on vulnerable satellites locked in predictable orbits to a more dynamic, survivable force structure that is capable of winning





# What is space maneuver warfare?

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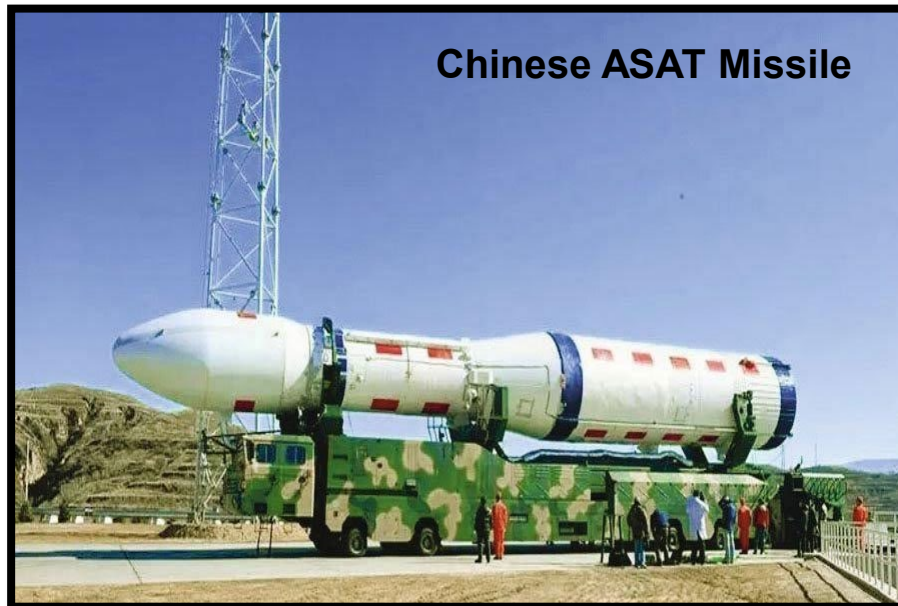
- **More than physically maneuvering faster than an enemy's forces, includes maneuvering around an enemy's strengths to attack its physical and psychological centers of gravity**
  - An enemy's center of gravity is its greatest weakness, not its greatest strength
- **A successful space maneuver warfare campaign must hit an adversary's vulnerabilities hard, fast, and continuously**
  - Must have the capability to proactively deter an attack while simultaneously seizing the initiative and positioning to deny or degrade an enemy's space warfighting options

**The objective of maneuver warfare is to establish and sustain your strengths while exploiting enemy weaknesses**



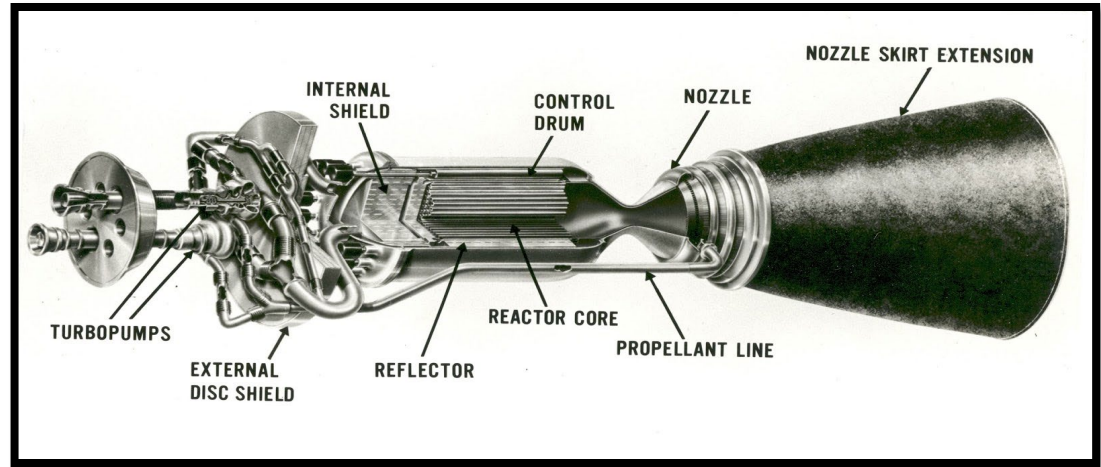
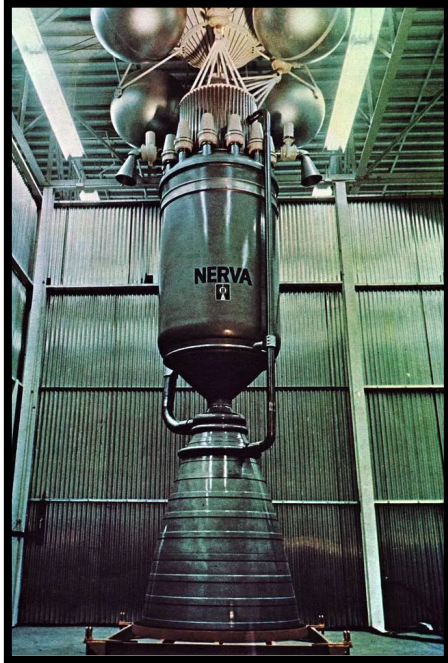
# China sees nuclear thermal propulsion as a key to space maneuver warfare

- The U.S. is behind in fielding the proper space weapons systems for both defensive and offensive operations to the Chinese
- China intends to field nuclear thermal propulsion vehicles with enhanced maneuver advantages over the current U.S. constellation-based force design by 2040
  - Given their long-view of development, these systems could be operational as soon as the 2030s





# U.S. has invested in space nuclear thermal propulsion (SNP) technologies for decades



- The U.S. has studied, tested, and regulated highly enriched uranium-based nuclear thermal propulsion systems since the late 1940s, **but never flew them** due to self-induced policy and budgetary restraints
- DoD's NERVA was the first SNP engine to be certified for flight but was cancelled in the early 1970s
- SDI pursued a SNP program for missile and space defense weapons systems, but was cancelled in early 1990s
- DARPA Demonstration Rocket for Agile Cis-Lunar Operations





# Strategic and operational benefits of a SNP-based space force

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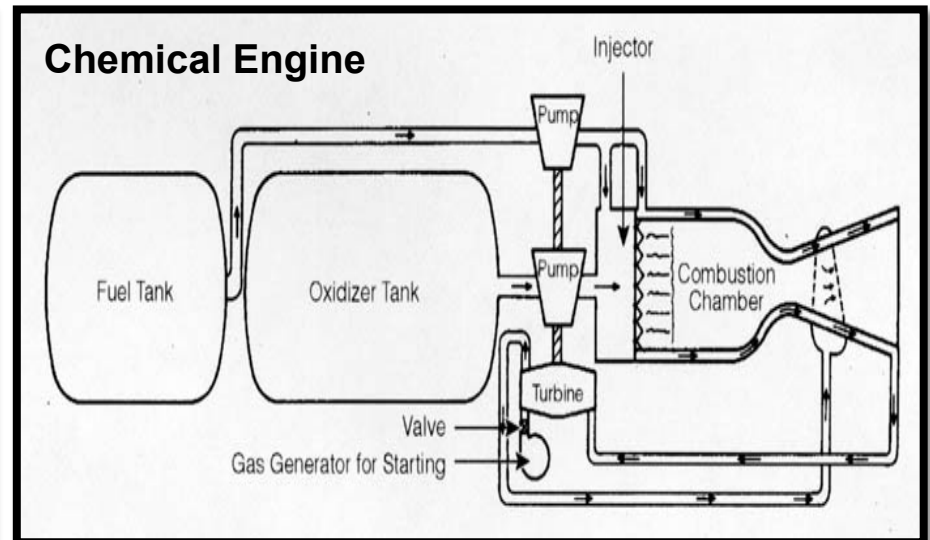
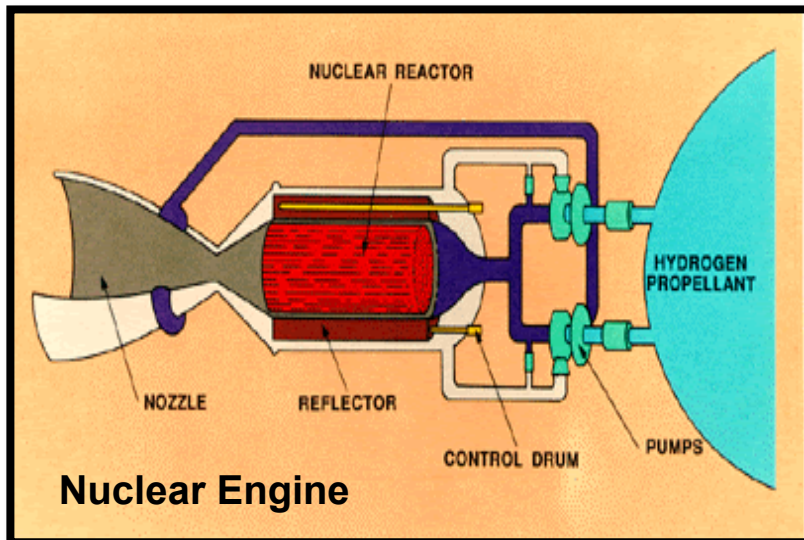
1. **SNP is more reliable:** Chemical propulsion is essentially a controlled explosion, everything must work perfectly to operate at peak performance—these interactions do not occur with SNP, making it a simpler, more reliable alternative
2. **SNP is more efficient:** SNP can operate with less “fuel” than their chemical counterparts and can operate for longer mission times
3. **SNP has increased energy density:** SNP can deliver more than 100,000 Newtons of thrust—enough to accelerate a car from 0-60 mph in less than a quarter of a second. SNP engines with Uranium have an energy density 4 million times greater than hydrazine, a chemical propellant in many satellites;
4. **SNP in space is safe:** SNP are essentially “heating units” that stimulate propellant via nuclear energy; they are in a “cold state” until turned on in when needed for propelling the vehicle in a nuclear safe orbit





# SNP space vehicles and safety

- Engineers have improved SNP reactor designs and procedures for human safety
- These reactors are kept in a “cold state” that does not generate radiation during storage, launch, and early flight. Only on when needed.
- SNP has no combustion--it heats the propellant in the reactor to generate thrust





# Six recommendations for the U.S. Space Force

**“Delta-V is the coin of the realm”**

**General (ret.) Kevin Chilton, USAF, former astronaut and  
MI-SPACE Explorer Chair for Space Warfighting Studies**

- 1. Adopt a new U.S. space force design capable of decisive maneuver warfare in space**
  - Without the ability to rapidly maneuver, DOD’s disaggregated and proliferated LEO systems will only provide additional targets for Chinese and Russian kinetic and non-kinetic counterspace weapons systems
- 2. Field SNP and other space tech to deter and defeat threats**
  - DoD, in partnership with NASA and the Department of Energy, should develop and field SNP and other technologies that will increase their ability to deter and defeat threats against the U.S. national security space architecture. After nearly 70 years of development, experimentation, and testing, now is time to operationalize SNP space systems



# Recommendations (continued)

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## **3. Allocate resources to operationalize DARPA DRACO**

- Beginning in FY24, allocate resources to move DARPA's DRACO program from S&T development to a full acquisition program – this will help DoD operationalize a space maneuver warfare-based force design before America's strategic competitors

## **4. Until SNP forces are fielded, deploy ground-based and space-based kinetic ASAT weapons to hold Chinese and Russian targets at risk**

- Will provide U.S. leadership with near-term options to deter and defend against ASAT threats
- One near-term is to repurpose existing capabilities such as SM-3 and Ground Based-Mid Course (GBI) missiles

## **5. Deploy a temporary hedge for added maneuver to vital constellations**

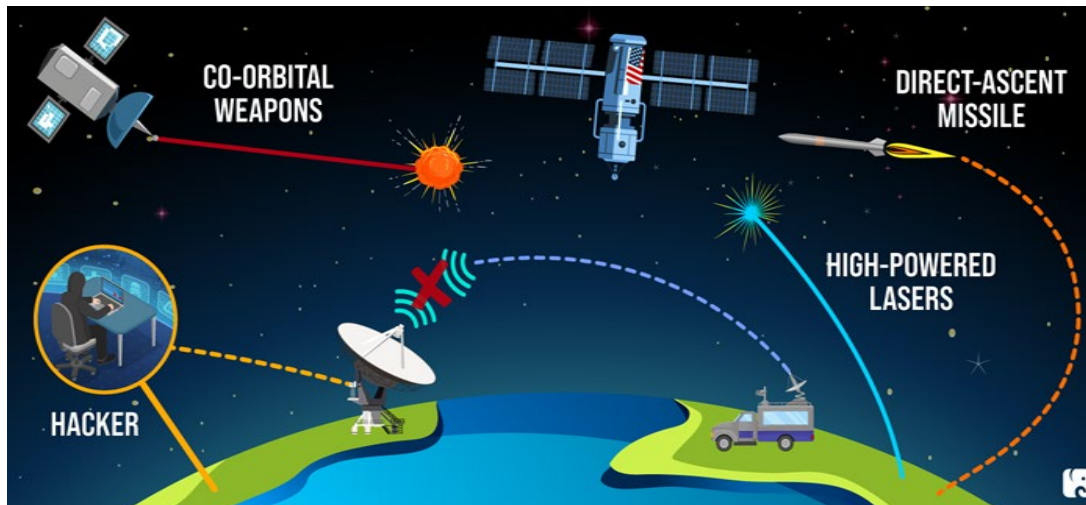
- Leverage the Mission Extension Vehicle (MEVs) to provide GPS and other vital satellite constellations the ability to conduct limited maneuvers while preserving onboard propellant



# Recommendations (continued)

## 6. USSF must improve its education and advocacy efforts

- Educate the public and Congress on the growing threat to U.S. space systems and the need to create a more robust force design that will enhance deterrence
- SNP can help create this agile, maneuvering force capable of generating a wide range of offensive and defensive effects in, from, and to space at a time and place of our choosing
- Space as a warfighting domain was created by the Chinese and Russians. We must be ready.



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