MITCHELL INSTITUTE
for Aerospace Studies

Orbital Vigilance: The Need for Enhanced Space-Based Missile Warning & Tracking

Christopher Stone

Senior Fellow for Space Studies,
MI Spacepower Advantage Center of Excellence

Why this study now?

The Era of Space & Missile Warfare is Here!

- **The U.S. homeland and forward bases are at risk of hypersonic attack**
- **U.S missile warning system not designed for a warfighting space domain**
- **Missiles have become key long-range strike option for adversary states**

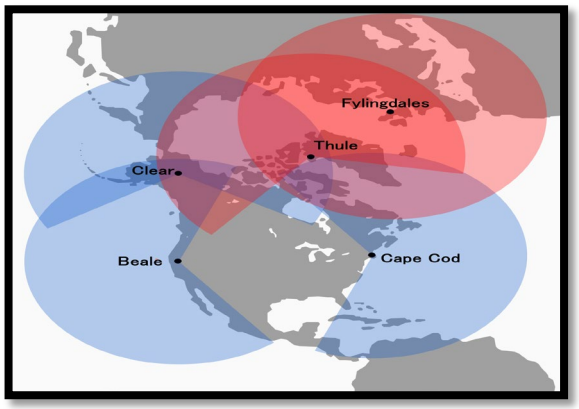
"The threats are really growing and expanding every single day. And it's really an evolution of activity that's been happening for a long time,"

General DT Thompson
Vice Chief of Space Operations

Background of Current Missile Warning

Current Systems Reflect Past Threat Requirements

- **Combination of ground radars and GEO space-based infrared sensors designed for global and theater ballistic missile warning ONLY**
  - Ground-based radars were insufficient to address the speed of intercontinental ballistic missile (ICBM) threats during the Cold War for NORAD and SAC
  - Space-based at Geosynchronous Earth Orbit (GEO), early warning satellites for nuclear forces became global, strategic missile warning assets
  - Growth of theater ballistic missiles after the Gulf War led to the need to update sensors capable of warning for both global and theater missile threats



Phased Array Radars

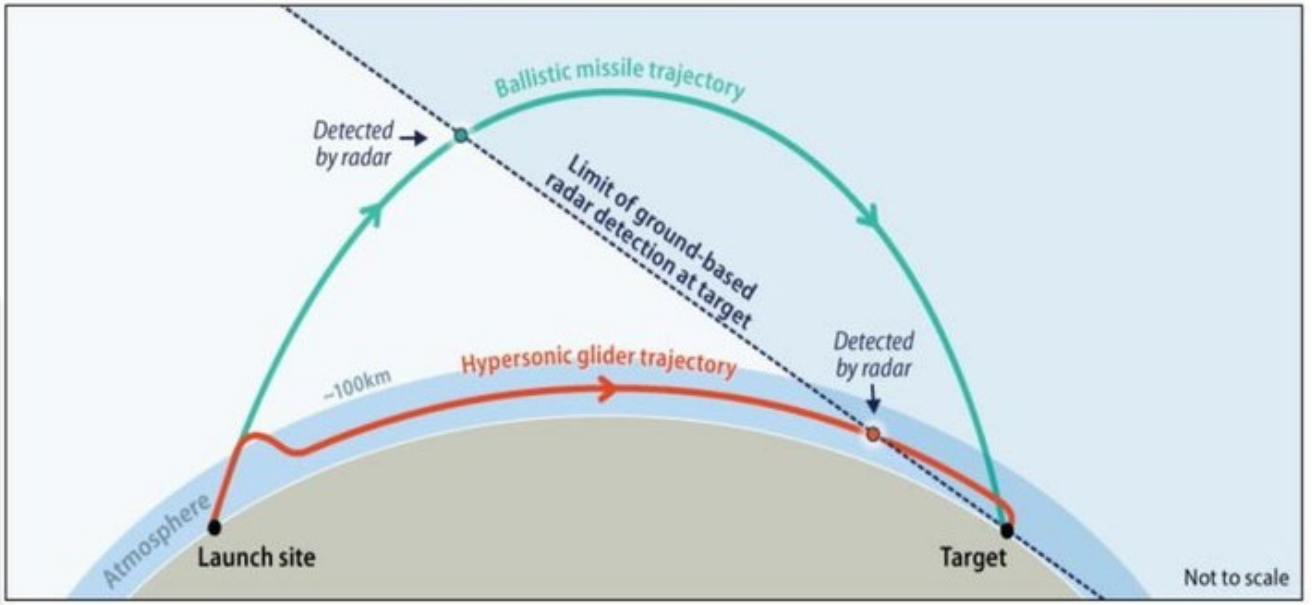
Space Based Infrared System (SBIRS)

The threat: China and Russia have developed new advanced space & missile threats to exploit gaps

- Designed to exploit gaps in current U.S. missile warning architectures
- Hypersonic boost-glide and air-breathing scramjet weapons that fly non-ballistic flight paths at lower altitudes and can maneuver
- Capable of carrying conventional and nuclear warheads

Chinese DF-17 missile

Russian Avangard hypersonic boost-glide weapon

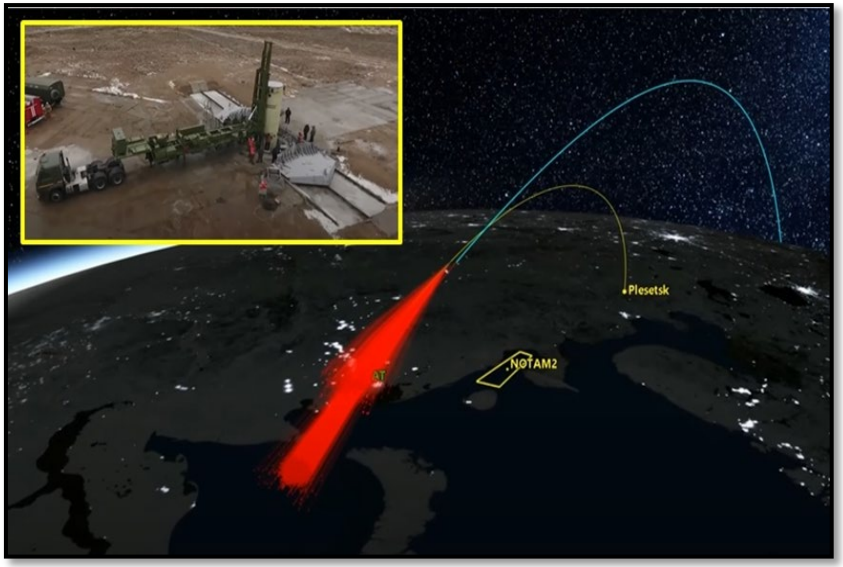


Ground-based radars cannot detect and track these threats over their entire flight paths.

China and Russia have developed new advanced space & missile threats to defeat U.S. forces

- **U.S. must be capable of operating in a warfighting, space domain**
- **China and Russia have developed, deployed, and used space and counterspace capabilities (kinetic and non-kinetic) to exploit vulnerability of critical space infrastructure like MW constellations**
  - "Multi-layered attack architecture"
  - "…hard to defend and easy to attack"

Chinese ASAT missile



Russian Anti-Satellite Missile System (NUDOL)

Attributes of Current Deployed Capability

Bottom Line: Current U.S. missile warning architecture *not* designed for today's space and missile threat environment

Current Missile Warning System	Geosynchronous Earth Orbit (GEO) (SBIRS)
Global Coverage	
Resilience/Survivability Against Counterspace Threats	
Persistent Warning of Missile Launches	
Persistent Tracking of Hypersonic, Low-Flying, Missile Systems	
Possesses Defensive Measures (i.e., maneuver, decoys, active defenses)	

Competitive, not integrated development

Space Development Agency

- National Defense Space Architecture Tracking Layer
  - Proliferated Low Earth Orbit (LEO)

Missile Defense Agency

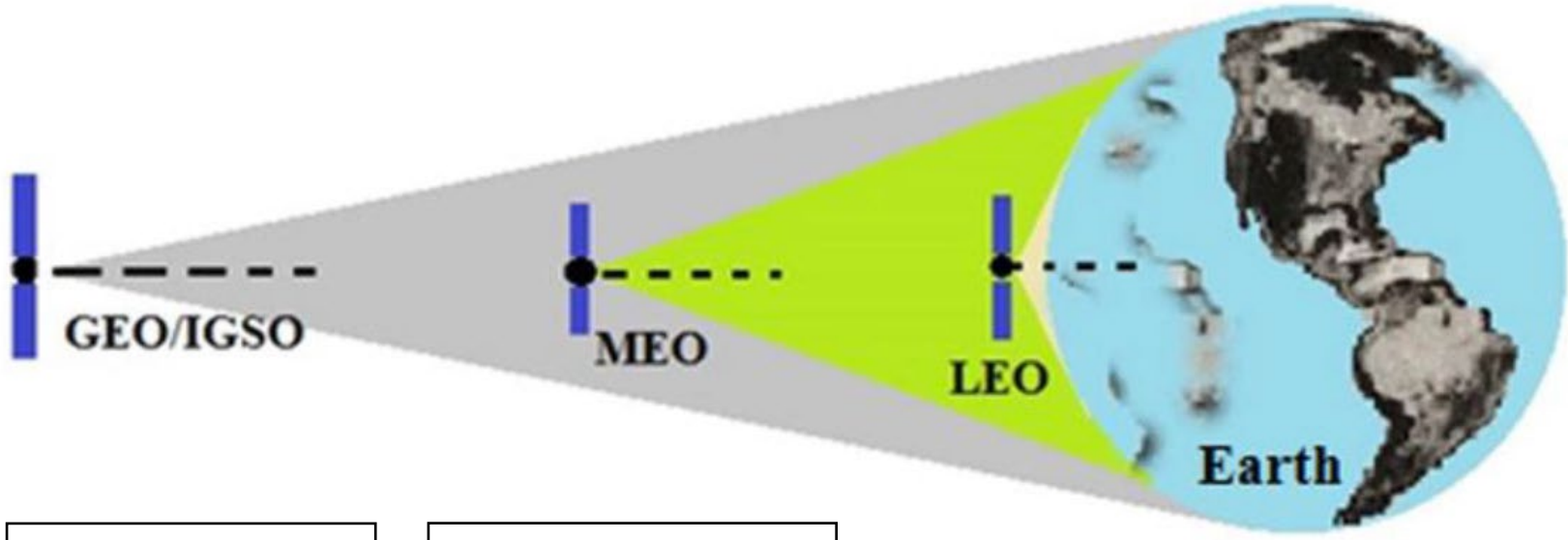
- Hypersonic & Ballistic Tracking Space Sensor (HBTSS)
  - Proliferated LEO – Fire Control Tracking

U.S. Space Force

- Medium Earth Orbit (MEO)- Tracking
- Next Generation Overhead Persistent Infrared (OPIR)
  - Geosynchronous Earth Orbit (GEO)
  - Highly Elliptical Earth Orbit (HEO)
  - Polar Orbit

Solution: Shift to a multi-orbit architecture capable of warning and missile tracking

- **Combine current concepts into integrated tracking architecture**
- **Capability to achieve all required attributes lacking in today's system**



- Lower Fidelity IR
- Medium Threat, Global coverage
- (1/3d Earth per Satellite)

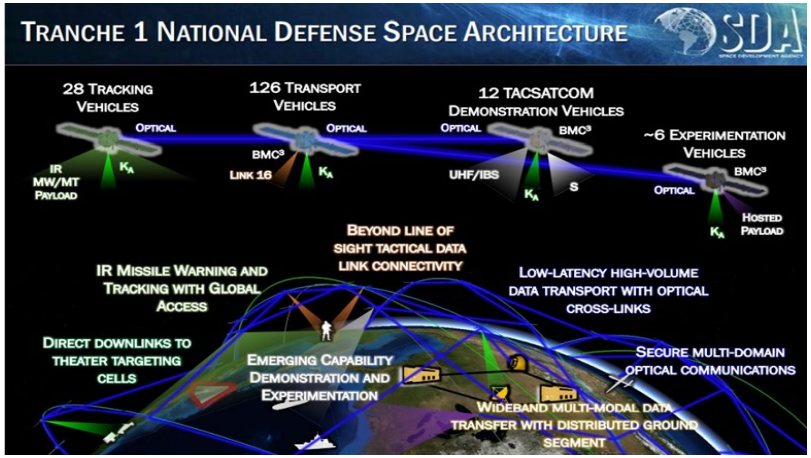
- Medium Fidelity IR
- Larger Field of View,
- Moderate tracking (min-hours)

- Hi-Fidelity IR,
- High Threat,
- Small Field of View,
- Shortest tracking (5-10 min)

LEO Basing Concept

Assessment:

- **Proliferated-LEO National Defense Space Architecture (NSDA)+HBTSS**
  - Space Development Agency's multiple satellite constellation for hi-fidelity, infrared tracking of maneuvering threats
  - Resilience in numbers, frequent update of sats (2–3-year tranches)
  - At risk of counterspace threats



Future LEO+GEO Concept-no defensive measures

	Low Earth Orbit (LEO) Options	Geosynchronous Earth Orbit (GEO) Options
Global Coverage		
Resilience/Survivability Against Counterspace Threats		
Persistent Warning of Missile Launches		
Persistent Tracking of Hypersonic, Low-Flying, Missile Systems		
Possesses Defensive Measures (i.e., maneuver, decoys, active defenses)		

MEO Basing Concept

Assessment:

- **MEO basing concept:**
  - **Longer tracking time than proliferated-LEO, higher fidelity than GEO**
  - **Added resilience for LEO and coverage due to higher altitude**
  - **At risk of counterspace threats, but less so than LEO**
  - **Between 9 to 36 satellites for global coverage**
  - **Altitude between 2,000 km and 35,766 km**

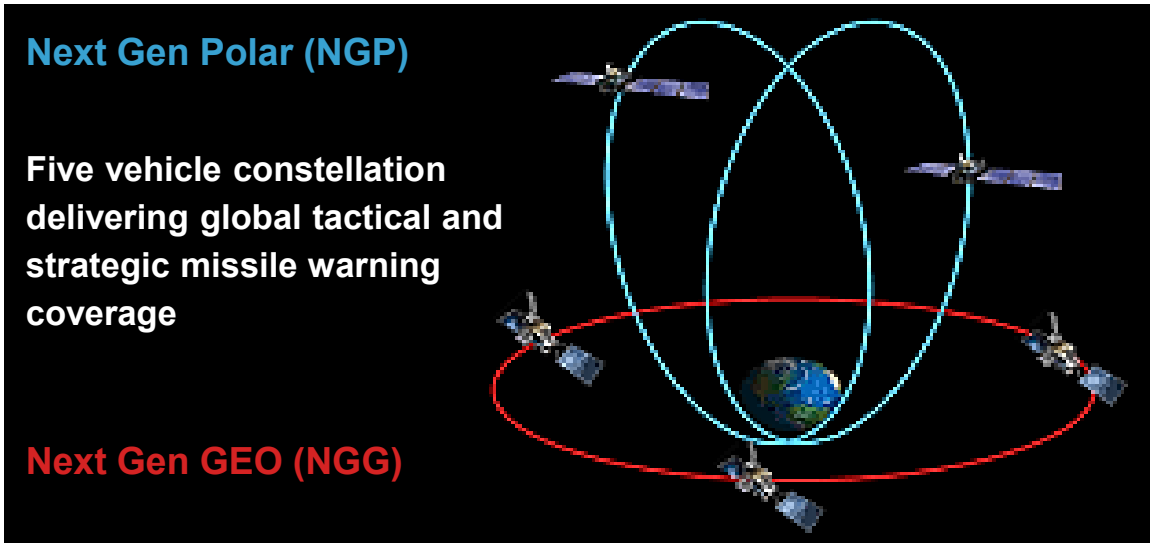
Future LEO+MEO+GEO concept-no defensive measures

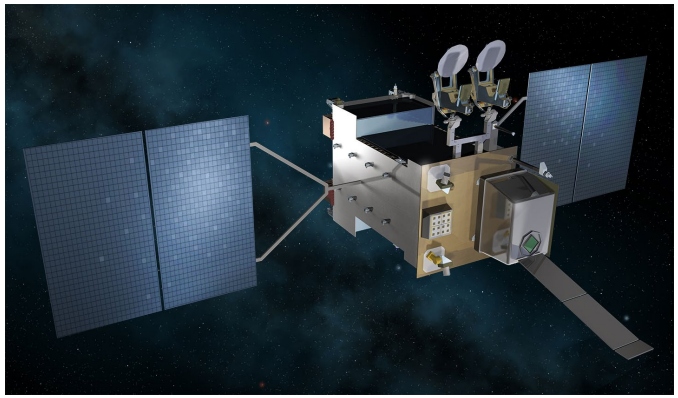
	Low Earth Orbit (LEO) Options	Medium Earth Orbit (MEO) Options	Next Gen Geosynchronous Earth Orbit (GEO) Options
Global Coverage			
Resilience/Survivability Against Counterspace Threats			
Persistent Warning of Missile Launches			
Persistent Tracking of Hypersonic, Low-Flying, Missile Systems			
Possesses Defensive Measures (i.e., maneuver, decoys, active defenses)			

GEO Basing Concept

Assessment: Updated version of current system

- **GEO, polar basing concept:**
  - **5 satellites in GEO and 2 in Polar Orbit**
  - **Designed for "open architecture"**
  - **Improved sensors and rapid downlink capabilities**
  - **Less at risk of some counterspace threats**





Post-MI Recommendations Future Concept

	Low Earth Orbit (LEO) Options	Medium Earth Orbit (MEO) Options	Next Gen Geosynchronous Earth Orbit (GEO) Options
Global Coverage			
Resilience/Survivability Against Counterspace Threats			
Persistent Warning of Missile Launches			
Persistent Tracking of Hypersonic, Low-Flying, Missile Systems			
Possesses Defensive Measures (i.e., maneuver, decoys, active defenses)			

Four recommendations for DOD

"For me, and I know for my leadership in the administration, there are no more important areas to prioritize than missile warning…."
Secretary of the Air Force Frank Kendall

1. **Adopt a multi-layered satellite architecture that combines legacy ballistic missile warning capabilities with enhanced sensors in LEO, MEO, GEO, and Polar orbits to detect and track hypersonic weapons and other novel missile threats over their entire flight profiles**

2. **Develop the capability to deploy decoy satellites in LEO and MEO orbital regimes to complicate Chinese and Russian counterspace targeting operations**
   - This defensive measure would enhance deterrence and increase the resiliency of DOD's space-based missile warning architecture in a conflict

Four recommendations for DOD (continued)

3. Transition MEO and GEO missile warning and tracking satellites that use chemical-based propellants with limited lifespans to advanced propulsion capabilities that enhance their ability to maneuver to avoid attacks and change orbits post attack

4. DOD should rapidly and overtly field kinetic and non-kinetic ASAT system in sufficient numbers to hold adversary space systems at risk to enhance deterrence, and if deterrence fails, to win.

www.mitchellaerospacepower.org