Countering China's Rendezvous Spacecraft and Ground-Based Laser ASAT

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Dual-Use R-Spacecraft

- **Spacecraft with robotic arm(s) capable of rendezvous and proximity operations (RPO)**
  - **Peaceful services:**
    - **Refuel, repair, upgrade or transport satellites**
    - **Remove space debris**
  - **Antisatellite (ASAT) uses:**
    - **Move satellites harmlessly to useless orbits**
    - **Bend or disconnect antennas and solar panels to disable satellites with little debris**

Rendezvous ASAT spacecraft can be indistinguishable from their peaceful counterparts.

U.S. Officials Unanimously Confirm Threat from R-Spacecraft

- **During 2018-2020, at least 11 high-level space officials and agencies have concerns about R-spacecraft.**

- **In 2021, Gen. James Dickinson testified that "Shijian-17, a Chinese satellite with a robotic arm,….could be used in a future system for grappling other satellites."**

China's R-Spacecraft Successfully Docked and Transported Another Satellite

- **In January 2022, China's Shijian-21 docked with a dead satellite at GEO and moved it to an orbit 3,000 km above.**
- **Merely 2 years after Northrop Grumman attained the same fate with Mission Extension Vehicle (MEV)-1**
  - **Surprised many U.S. space experts**

China can now dock or transport to disable our satellites.

Current Approach to Counter R-Spacecraft Is Inadequate

- **Replace legacy constellations with dozen(s) expensive large satellites with proliferated constellations with numerous cheap smallsats**

- **The above approach is necessary but far from sufficient, because**
  - **Takes time to replace legacy constellations**
    - **In the 2020s, many vulnerable legacy constellations remain**
  - **Scolese, Director of the National Reconnaissance Office, said that even in the 2030s and beyond, there will be "some number of large satellites."**

China Could Mount a Space Pearl Harbor as Early as 2026 and We Are Unprepared

- **Chow and Kelley assessed that China could manufacture 200 small R-spacecraft by 2026**

- **Chow and Kelley estimated that 200 R-spacecraft could threaten the entire (legacy and legacy-like follow-on) constellations of U.S. satellites for**
  - **missile early warning (about a dozen at GEO and HEO)**
  - **communications in nuclear and conventional environment (about a dozen at GEO)**
  - **positioning, navigation, and timing (about three dozen at MEO)**
  - **Key communications, imagery, and meteorology (several dozen at GEO)**

- **Legitimate for an adversary to preposition any number of spacecraft arbitrarily close to our satellites**
- **We have inadequate warning and defense against attacks from close range.**

Deterrence and Defense against R-Spacecraft

- **Need warning/self-defense zones**
  - **June 2018, Trump Space Policy Directive-3: Rule to transit another satellite's safety "volume"**
  - **February 2023, Biden DoD Tenet #4: "Maintain safe separation"**
  - **However, without specifying a minimum separation, the rule is ambiguous and can cause misunderstanding and war**

- **Need small and cheap bodyguards**
  - **In October 2019, U.S. succeeded in docking and transporting**
  - **Yet, Pentagon has not applied these leading technologies in developing bodyguards or other effective measures to deal with the looming Space Pearl Harbor**

Current Approach to Space Traffic Management (STM) Will Leave U.S. under R-Spacecraft Threat

- **The West is pursuing an international STM that**
  - **focuses on commercial activities**
  - **is based on consensus for agreement**

- **Our current approach is doing China and Russia's bidding**
  - **They can use the commercial focus to gain access to the Western space market.**
  - **They can use the consensus rule to just say "no" to zones and bodyguards**

China can preposition R-spacecraft arbitrarily close to our critical satellites in peacetime or during crisis for a Space Pearl Harbor

A Dual-Track Approach to a STM for Peace and Prosperity

- **U.S. should pursue a Western STM and an international STM, both of which have zones and bodyguards.**
- **If China and Russia participate in Western space market, they should observe rules of zones and bodyguards in Western STM.**
  - **Even if they not participate, our bodyguard spacecraft would still block their spacecraft from reaching our satellites.**
- **Once they join the Western space market, it would be a baby step for them to join the international STM.**

Whether they join any STM or not, we would not be threatened by R-spacecraft

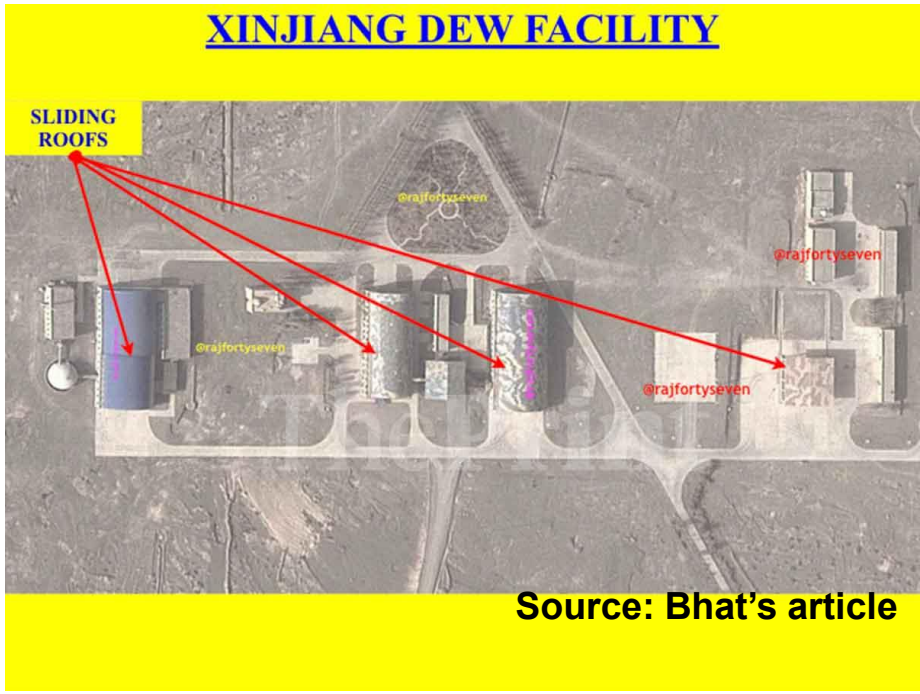
Ground-Based Laser ASAT Threat

- **In September 2006, NRO Director Donald Kerr confirmed that at least one American satellite had been illuminated by a Chinese ground-based laser.**

- **In January 2019, DIA warned**
  - **that "China likely will field a ground-based laser weapon that can counter low-orbit space-based sensors by 2020"**
  - **and repeated in April 2022 that "by the mid- to late-2020s, China may field higher power systems that extend the threat to the structures of nonoptical satellites" as well as optical satellites at LEO**

China's Xinjiang Laser ASAT Facility

- Indian Col. Vinayak Bhat, discovered the facility.
  - Four main buildings with sliding roofs
  - One for tracking satellites.
  - Lasers in other three could dazzle or damage satellite sensors.



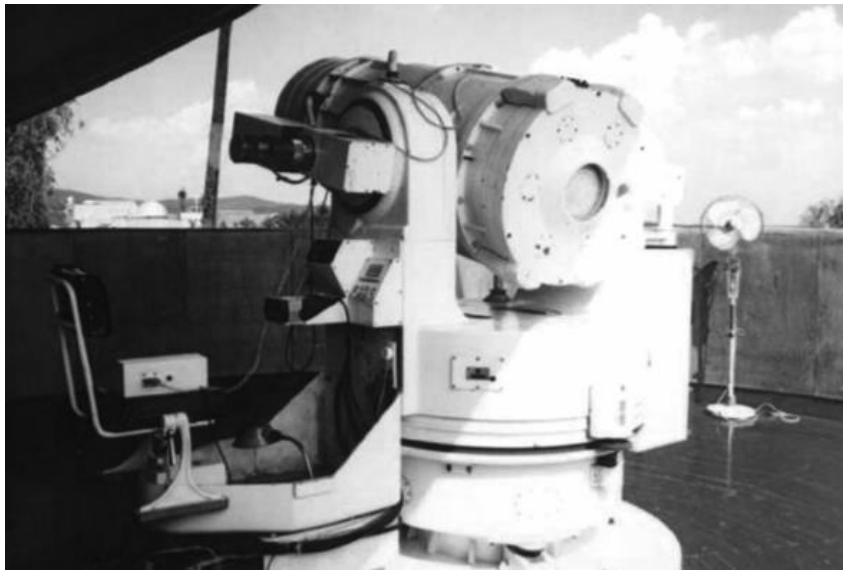
Source: Bhat's article

- Also, laser ASAT facilities at four other places.

If the Xinjiang facility is representative of the other four, all five bases can be located and vulnerable to aerial attacks

Dual-Use Satellite Laser Ranging (SLR) Stations Can Pose a Threat

- **SLR measures distance to a satellite to sub-centimeter precision.**
- **China has 5 fixed and 2 mobile stations.**
- **Yousaf Butt calculated: 0.1% (1 watt in typical station) or 0.2% (40 watts in experimental system) chance per satellite pass to damage the filters or pixels.**
  - **Frequent passing could multiply the small chances**



Source: Changchun station from Butt's article

A laser beam can only get into a telescope and cause damage, if the laser is located within roughly 10 km of a ground target that we want to take a picture of

Responses to Laser Threat to Satellite Sensors (Feasible Now)

- **Identify Chinese targets we want to take pictures of that have a laser within roughly 10 km.**
- **For these laser-protected targets,**
  - **Take pictures whenever possible during peacetime.**
  - **Update imagery less frequently.**
  - **Use as low a resolution for imagery as much as possible.**
- **The U.S. should secure imagery of all needed resolutions using commercial and dedicated military systems.**
- **The U.S. should negotiate with China to prohibit interference with national technical means (including sensor-carrying satellites)**

Responses to Fixed Laser Threat to Satellite Structures (Feasible by the 2nd Half of 2020s)

- **When Beijing acquires high-enough power lasers, satellites in LEO flying nearby can be damaged**

- **Washington needs to**
  - **make our satellite constellations resilient (e.g., by proliferation)**
  - **harden some satellites' exteriors and sensors**
  - **be prepared to disable China's laser systems if they attack our satellites.**

Responses to Mobile Threat to Satellite Sensors and Structures (Feasible by 2025)

- **The U.S. and its allies should disadvantage any hostile use with diplomatic measures that would provide warning.**
  - **For example, push for an international agreement to register all mobile dual-use lasers, require their operators to announce their planned movement a month in advance, and demand their movements and locations be broadcast in real time.**

No Confident that U.S. Can Counter Rendezvous Spacecraft or Ground-Based Lasers

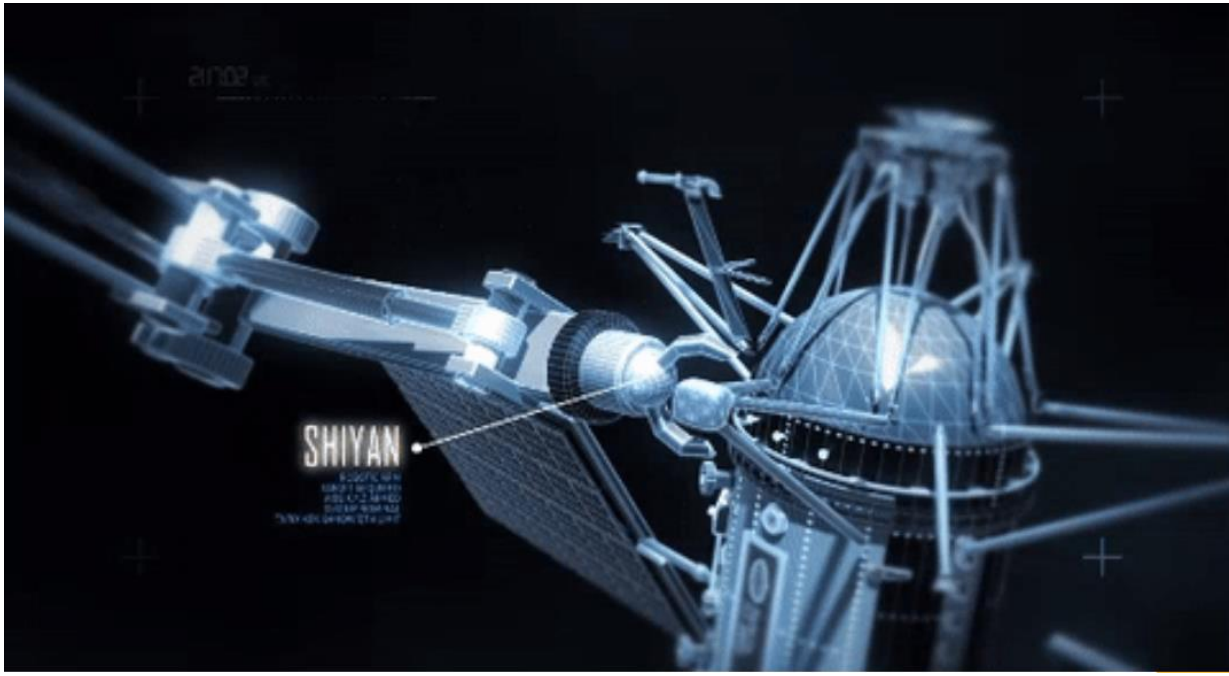
- **The looming danger: China mounts a Space Pearl Harbor (with 200 R-spacecraft) at the start of its campaign to seize Taiwan this decade**

- **Pentagon has not assured the public that we can deter this apocalypse. Instead,**
  - **Pentagon's ambiguous rule for "maintaining [unknown] safety separation" could create crisis instabilities and lead to war**
  - **As many critical satellites remain vulnerable this decade, Pentagon has not suggested an effective defense such as bodyguards to protect them**
  - **Pentagon has not suggested how to protect our satellites at LEO against high-power lasers especially mobile ones**

Additional Slides

6 Chinese RPO Tests Since 2008

- **200-kg Shiyan-7 (SY-7) has a teleoperated robotic arm. In 2013, SY-7 was repeatedly grabbing and then releasing its smaller partner.**



Source: Illustration by CNN

- **Martin, Pfrang and Weeden tallied 6 RPO tests in both LEO and GEO: Sept 2008; Jun-Aug 2010; Jul 2013-May 2016; Nov 2016-May 2018; and Jan-Aug 2020**

These tests lasted for months, even years. Well-tested, small and potentially cheap robotic RPO spacecraft are highly suitable for ASATs at the opening of a space war, with minimal space debris

Need Small and Cheap Bodyguards

- **MEV bodyguards overwhelmed by cheap attackers**
  - **MEVs too heavy (2,600 kg each) and too expensive (hundreds of millions of dollars each) to counter RPO attackers at 200 kg and tens of millions of dollars each.**
- **DARPA should apply Blackjack program to develop bodyguards.**