The Role of Space

Thoughts on space in the context of (nuclear) threat

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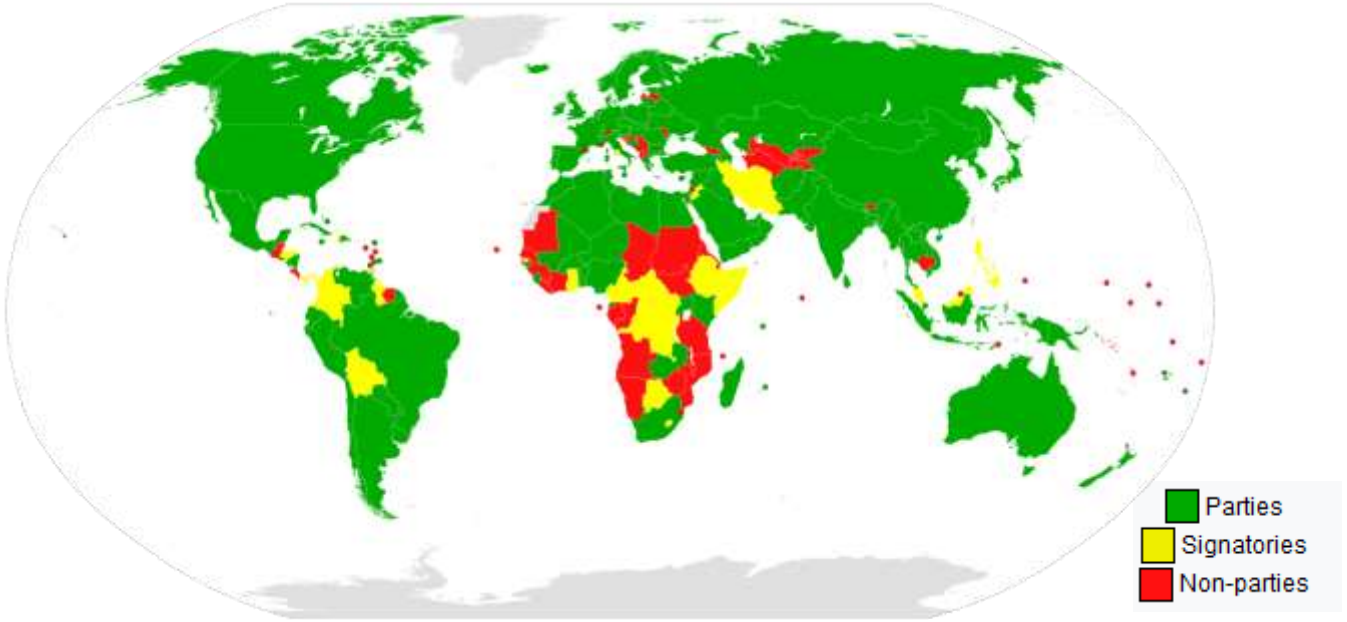
Overview

- Space
  - *What does "Space" mean?*
- Weapons in Space
  - *From missiles to exotic ideas*
- Conclusions

Space

Outer Space Treaty (1967)

- "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies"
- Key Features
  - *limit the use of the Moon and all other celestial bodies to peaceful purposes*
  - *establish that space shall be freely explored and used by all nations*
  - *preclude any country from claiming sovereignty over outer space or any celestial body*
  - *prohibit nuclear weapons in space*
- Forbids
  - *establishing military bases*
  - *testing weapons*
  - *conducting military maneuvers on celestial bodies*
- Does not expressly ban all military activities in space, nor the establishment of military space forces or the placement of conventional weapons in space.



Definitions of Space

- No Definition of (Outer) Space in the Outer Space Treaty

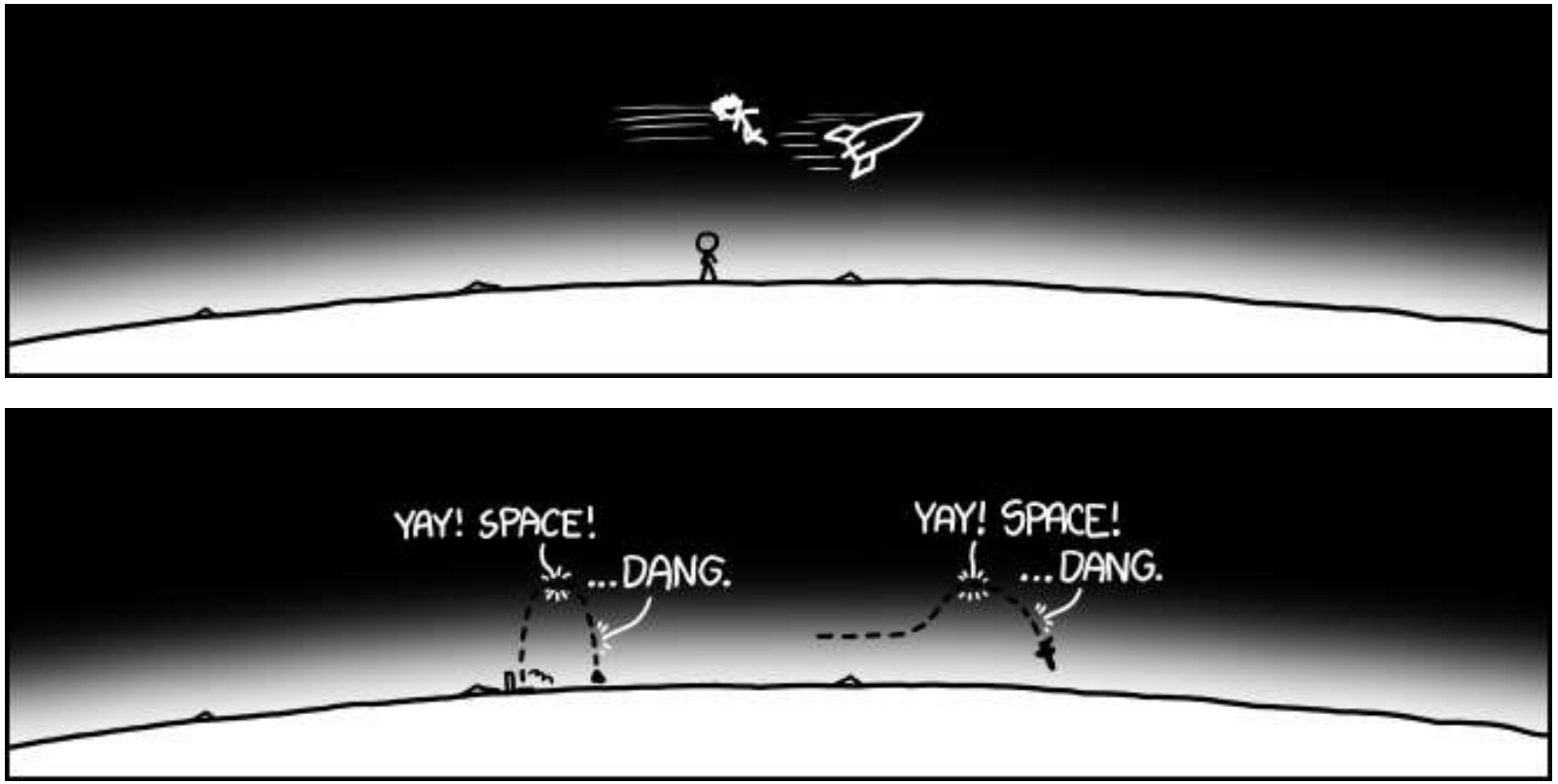
- Fédération Aéronautique Internationale (FAI):
  - *beyond 100 km altitude*
- United States Air Force (USAF):
  - *beyond 50 miles (80 km) altitude*

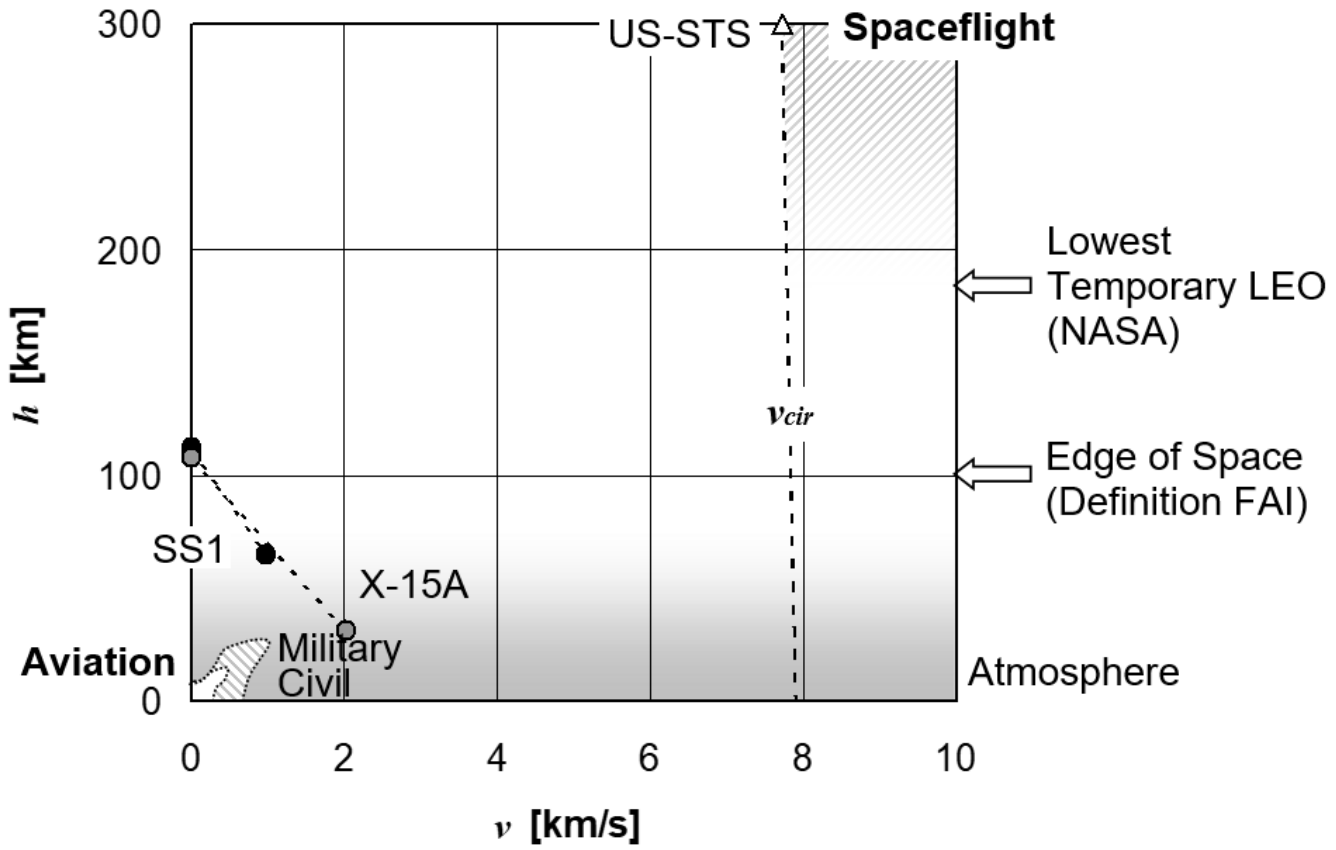
- No Definition of Spaceflight anywhere!

- Space is not this:

© XKCD (Randall Munroe)

- Space is like this:



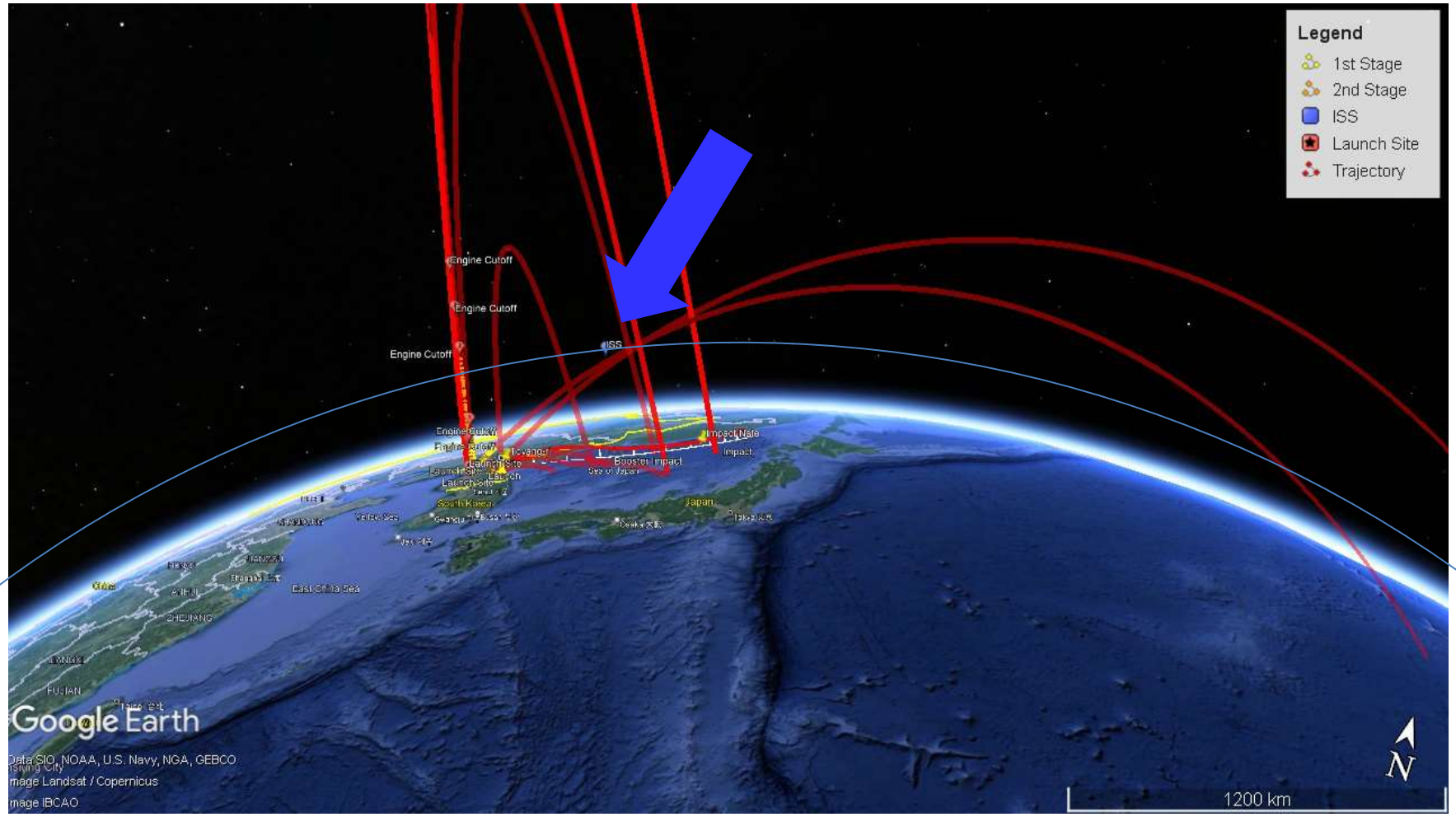


Speed and Altitude

Spaceflight is a question of velocity!!!

North Korean Hwasong-15 ICBM Launch (18 Feb 2023)

The missile travelled up to a maximum altitude of 5 768.5 km and flew 989 km for 4 015 seconds before accurately hitting the pre-set area in open waters of the East Sea of Korea. The company got an "excellent mark" at the assessment.



Various North Korean Missile Tests

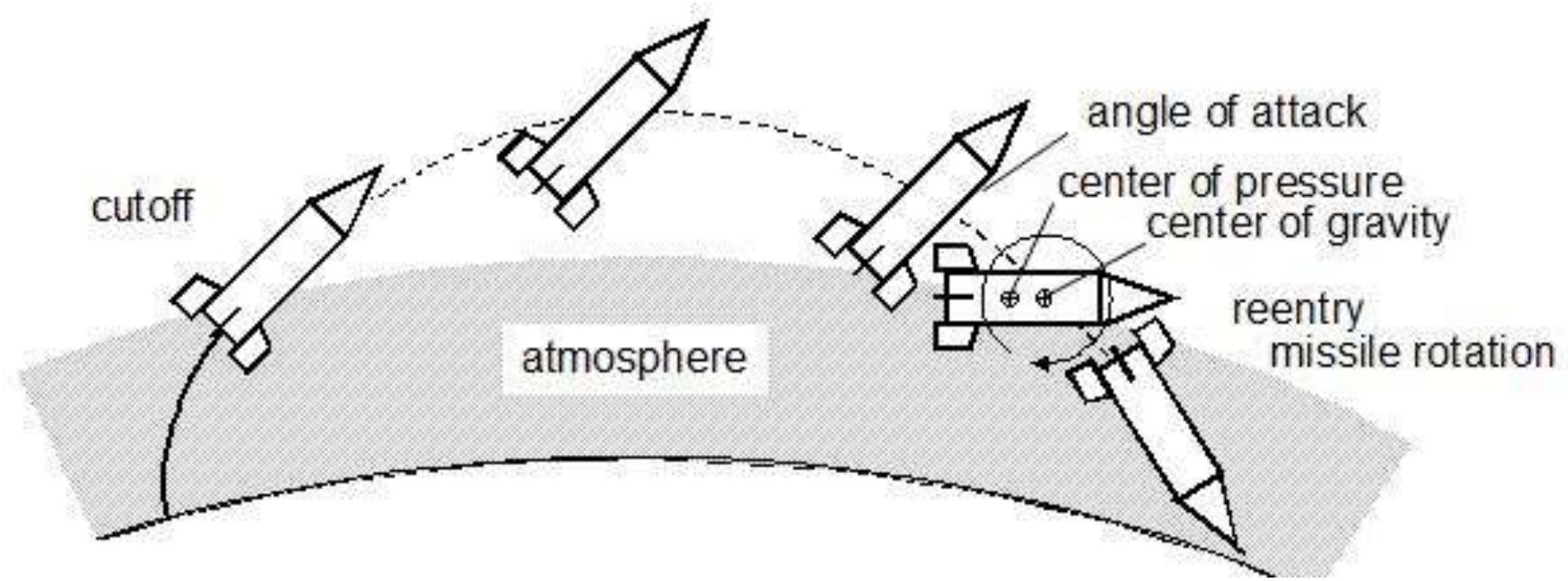
Some tests flew way beyond the International Space Station's orbit.

Weapons in Space

"Weapons" that are "in space" (at least by definition)

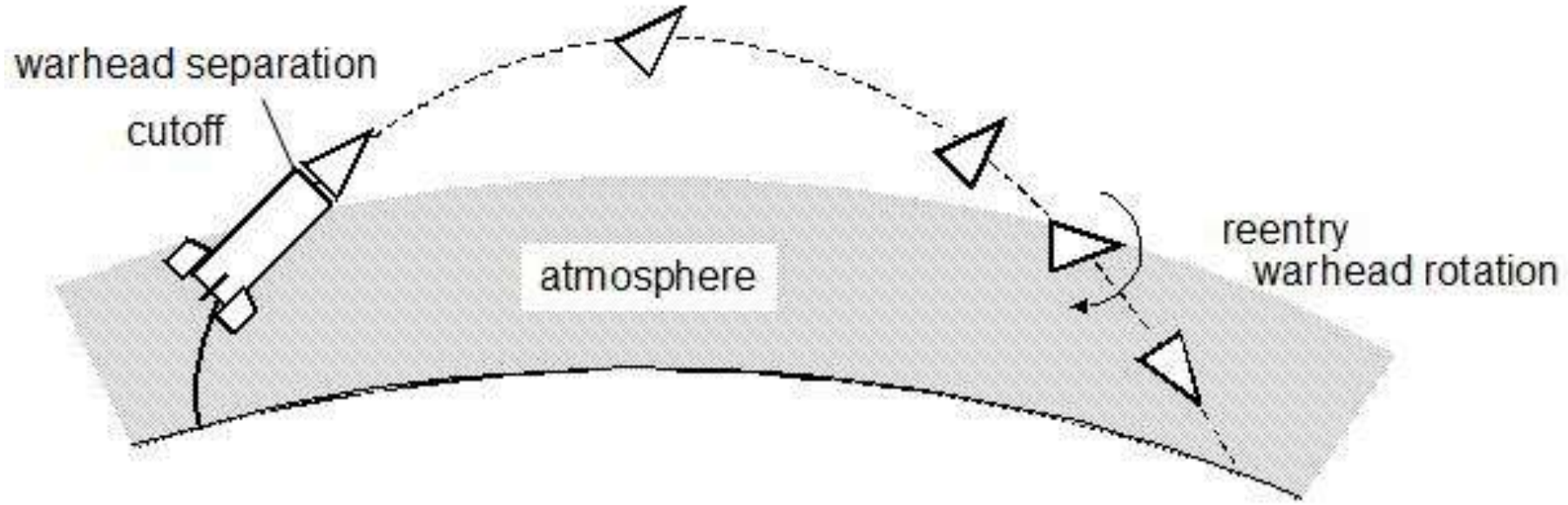
- Everything launched atop larger missiles
  - *Every missile 300+ km*
  - *Every warhead / reentry vehicle on top of missiles 500-700+ km*
  - *MaRVs (at some point)*
  - *HGVs (probably, at some point)*
  - *MRVs*
  - *MIRVs*
  - *IPBVs / "MaMIRVs"*
  - *ASAT* ← Targeting Space
  - *FOBS*
- Everything launched into orbit
  - *FOBS (yes, again)*
  - *Military satellites…?*
  - *Battle stations*
  - *Nuclear missiles*
  - *Rods from God*
  - *Killer satellites* ← Targeting Space

Targeting Earth



Warhead Integrated with the Missile

Once the missile reenters atmosphere, and aerodynamic forces gain hold, the missile body snaps back and reorients according to aerodynamic forces.



Separable Warhead – Unguided

Once aerodynamic forces gain hold, the warhead reorients according to aerodynamic forces.

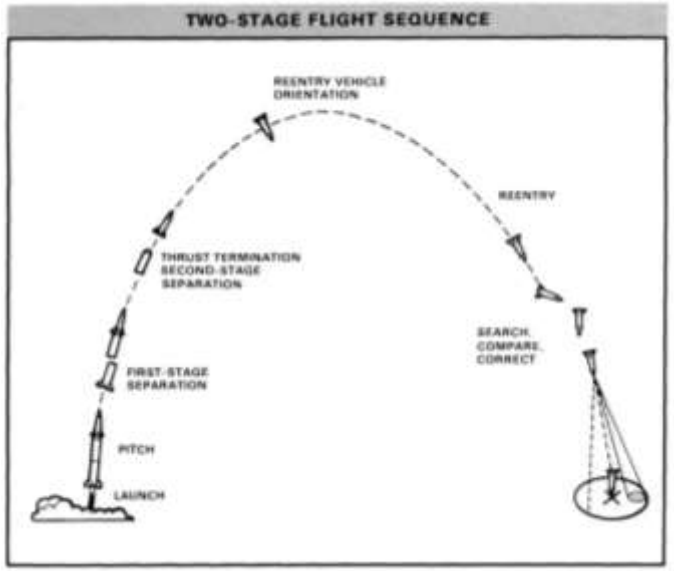
MaRV (Maneuverable Reentry Vehicle)

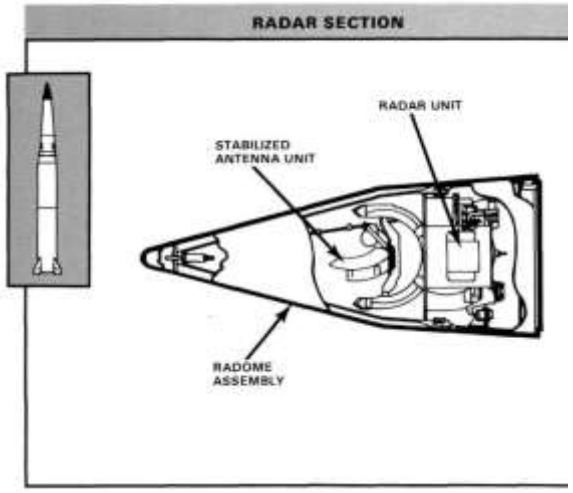
- Additions:
  - *airframe*
  - *guidance system*
  - *control surfaces*
  - *actuators*
  - *power supply*
  - *(homing sensors)*

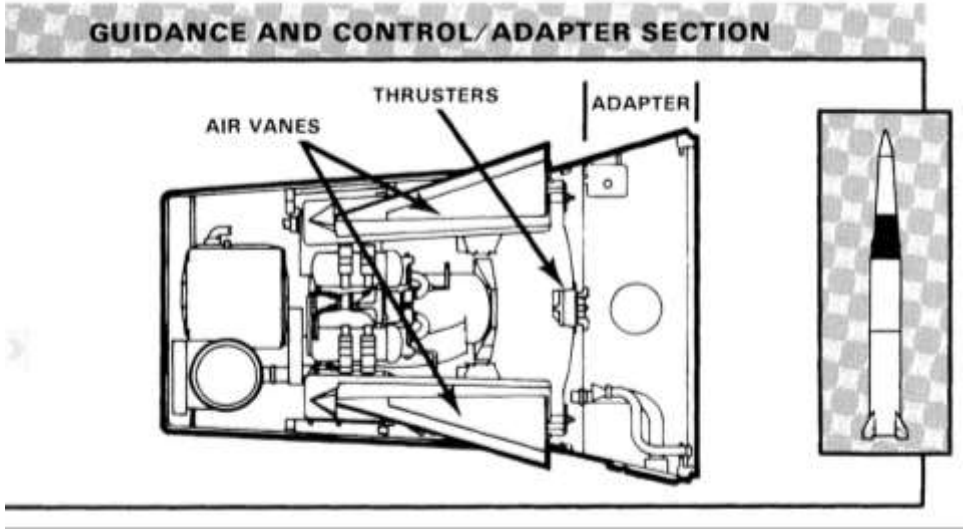
MaRV
(DF-26, China)

Pershing II (USA, 1970s/80s)

- W85 Nuclear Warhead
- MaRV
  - *warhead section 268 kg*
  - *total MaRV 680 kg*







Common Definitions: Hypersonic Glide Vehicle (HGV)

*„**Hypersonic glide vehicles** (**HGV**) are launched from a rocket before gliding to a target.“*

“Hypersonic Weapons: Background and Issues for Congress”,
Congressional Research Service, 17 March 2020.

*„**Hypersonic glide vehicles** (**HGV**s) are launched by rockets into near space, where they are released and fly to their targets by gliding along the upper atmosphere. They travel at the upper levels of hypersonic speeds and altitudes.“*

“Hypersonic Missile Proliferation”,
The RAND Corporation, 2017.

Hypersonic Glide Vehicle (HGV)

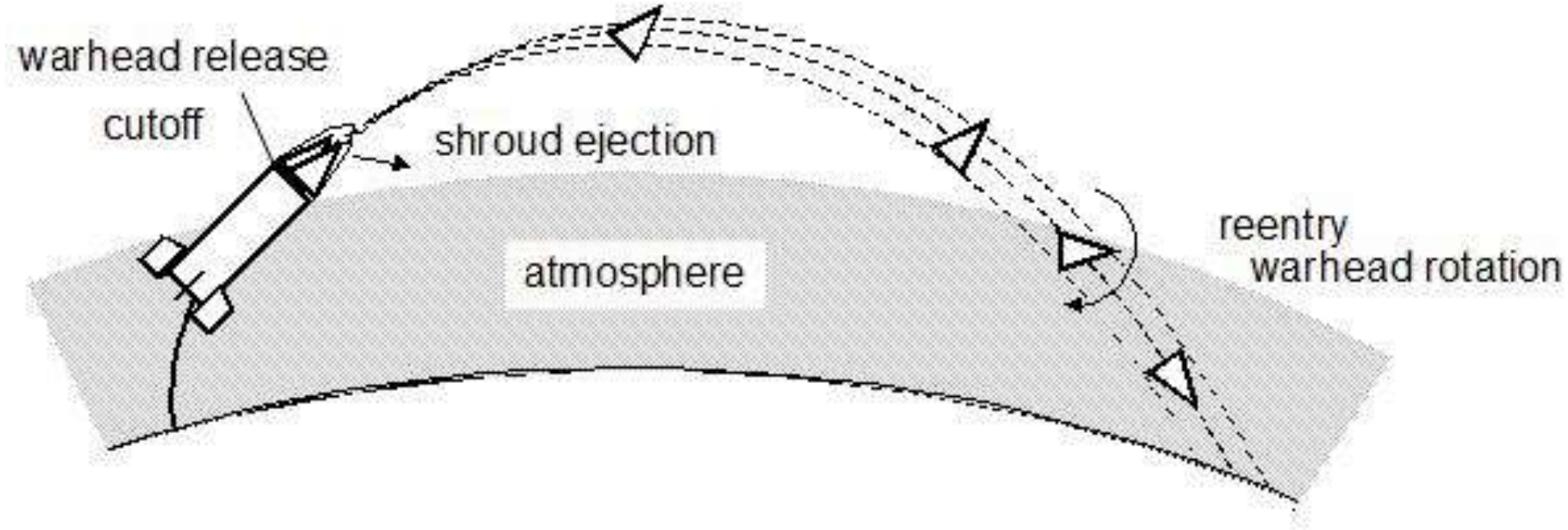
- Needs a Booster Rocket
- (Usually) Separates from Booster
- Requires
  - *Airframe*
  - *Guidance system*
  - *Control surfaces*
  - *Actuators*
  - *Power supply*
  - *Thermal protection system*
  - *Payload (weapon)*

A Hypersonic Glide Vehicle (HGV) is a Delivery System!

Multiple Warheads

- Multiple Reentry Vehicle (MRV)
- Multiple Independently targetable Reentry Vehicle (MIRV)
  - *Post-Boost-Vehicle (PBV) with Reentry Vehicles (RVs)*

NEW
  - *Maneuverable MIRVs / Multiple MaRVs*



Multiple Reentry Vehicle (MRV)

Similar to a shotgun shot.

reentry vehicles (3)

small fins

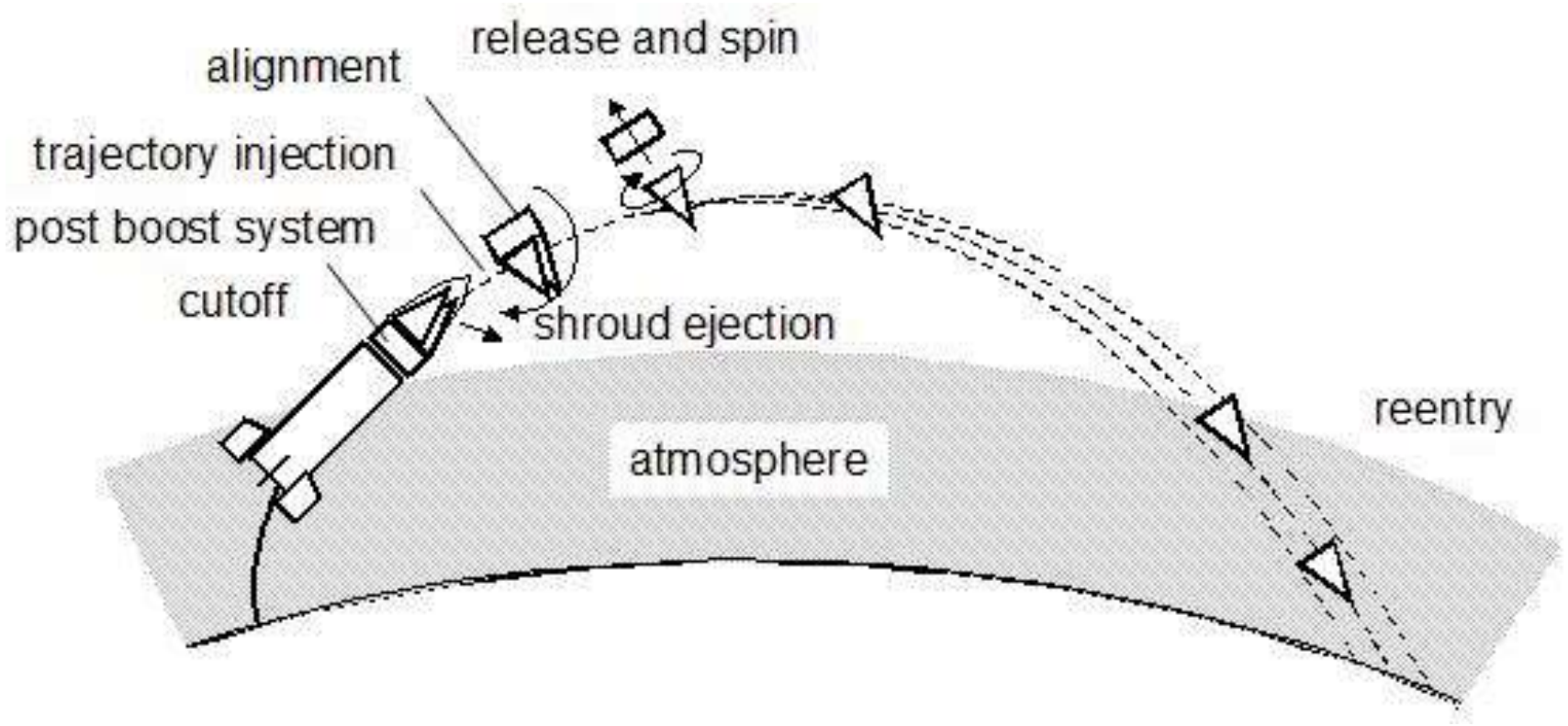
post boost system

thrust termination vents

2nd stage

Multiple Reentry Vehicles

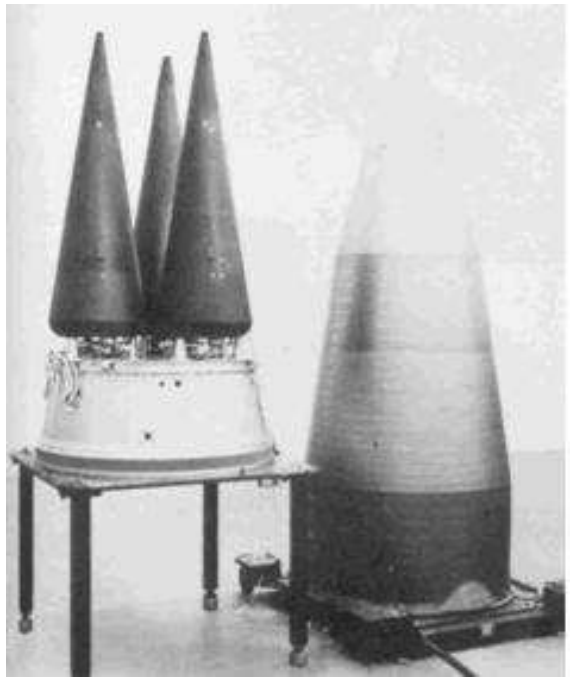
SS-20/RSD-10/Pionier, Soviet Union, 1970s/80s.



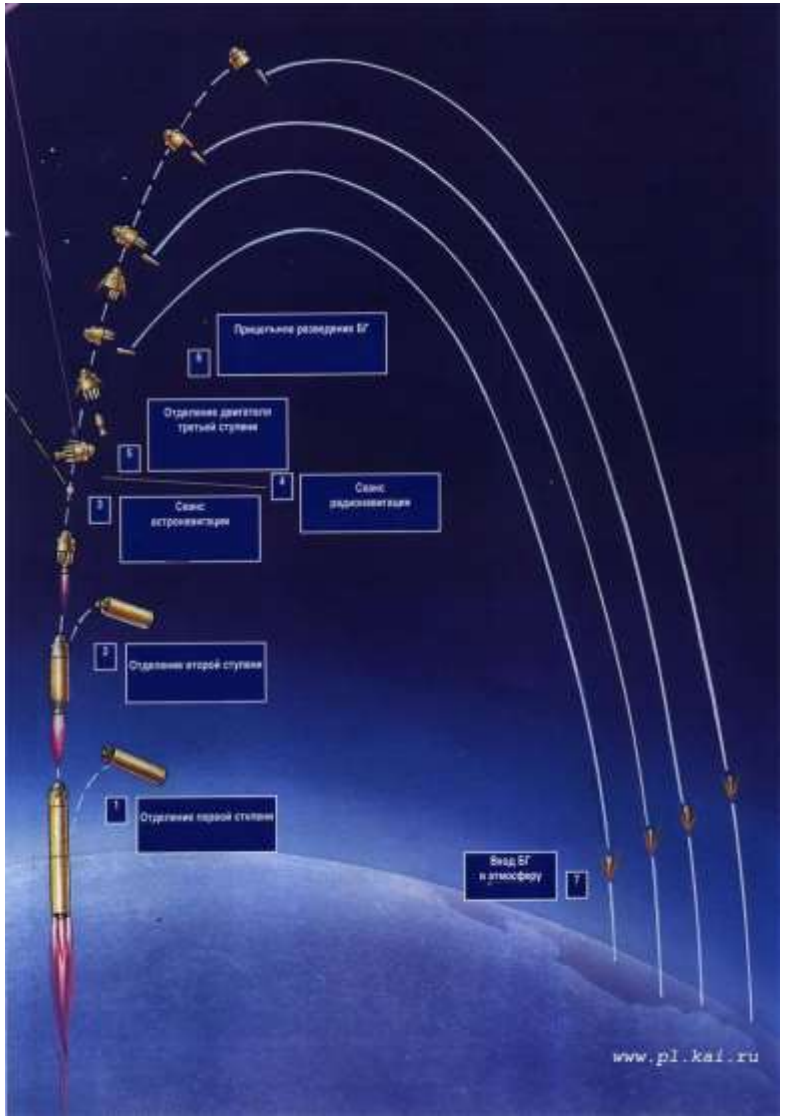
Multiple Independently targetable Reentry Vehicle (MIRV)

Autonomous bus system releases the RVs one by one, aligning each RV towards the intended target.

MIRVs



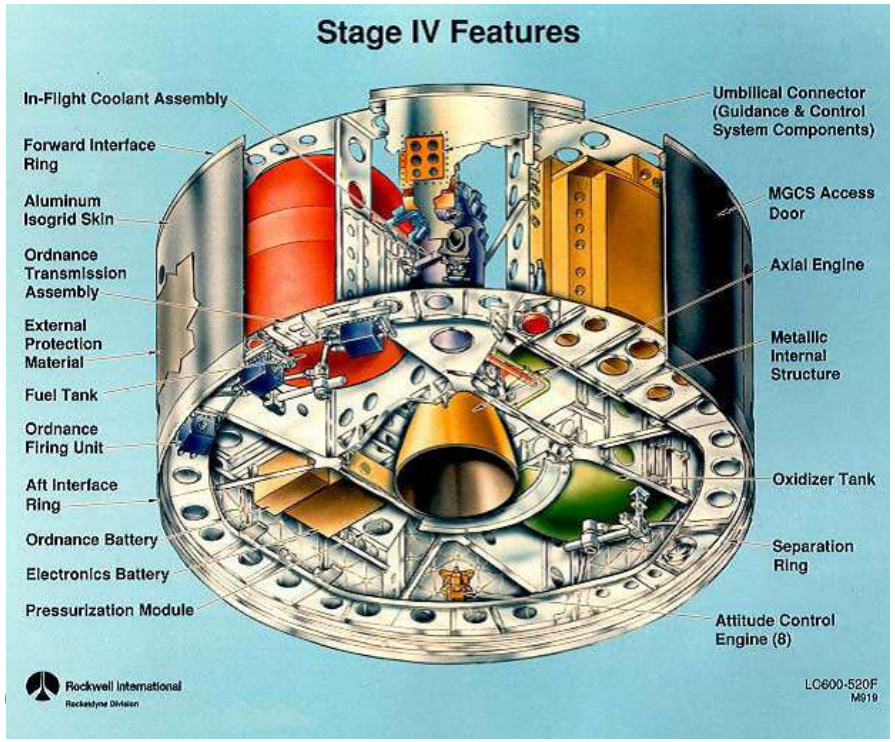
MIRVs
(Minuteman III, USA)



MIRV Sequence
(R-29RMU/SS-N-23, Soviet Union)

MIRVs

- LGM-118A Peacekeeper (USA, 1986-2005)



Independent Post Boost Vehicles (IPBVs) / "Maneuverable MIRVs (MaMIRVs)" ?

- Old Concept
  - *Mark 500 Evader (USA, 1970s)*

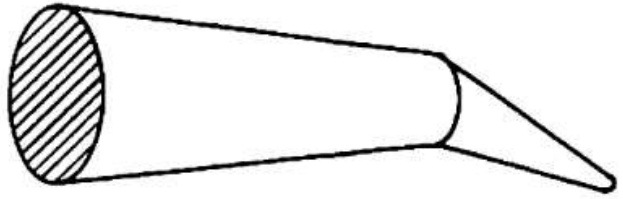
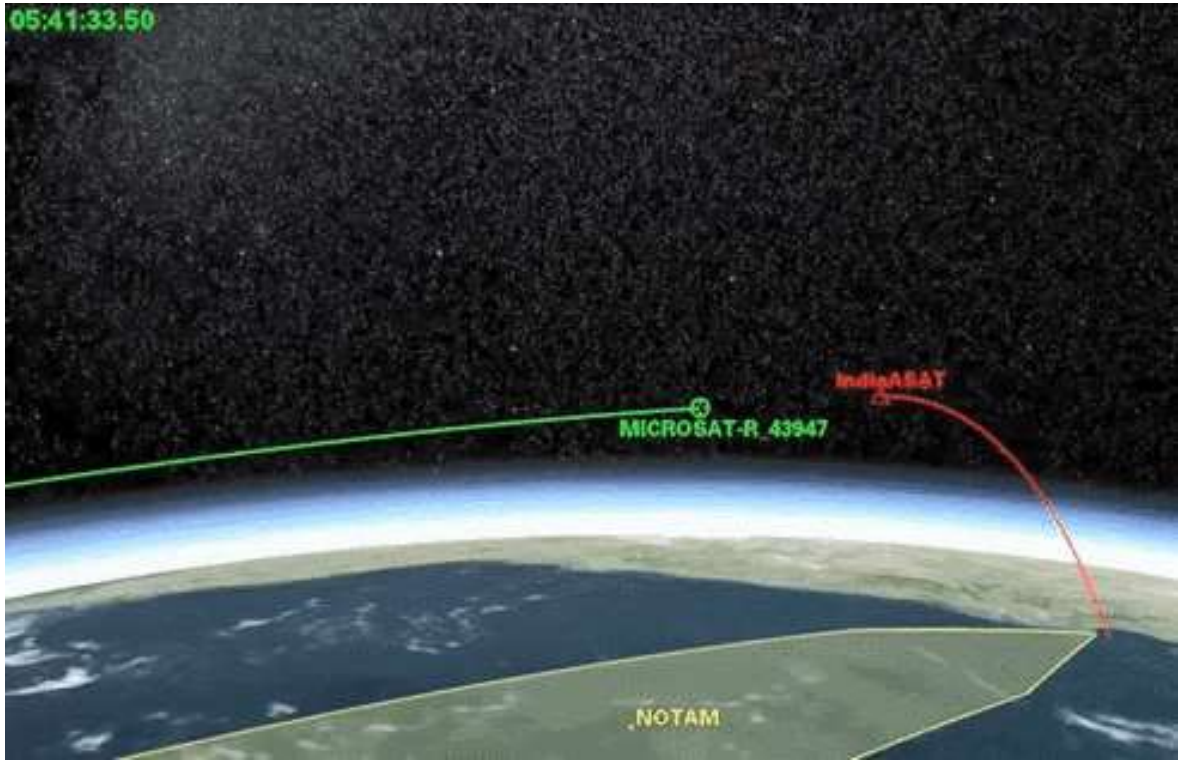


FIGURE 6.9. The Mk 500 "Evader"

- Modern Reports
  - *Russian efforts*

Direct-Ascent Anti-Satellite Weapons (ASAT)

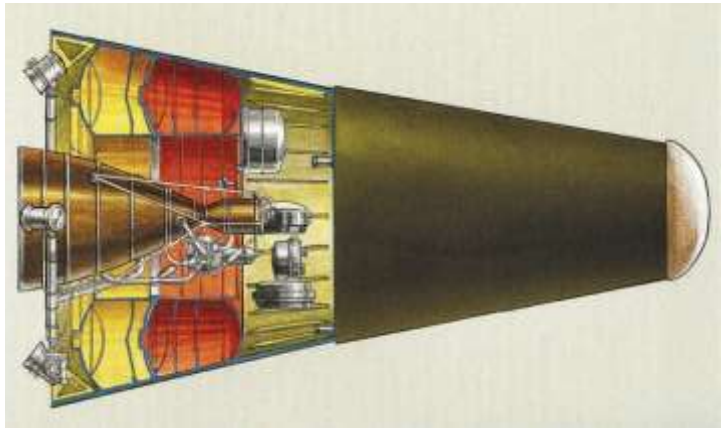


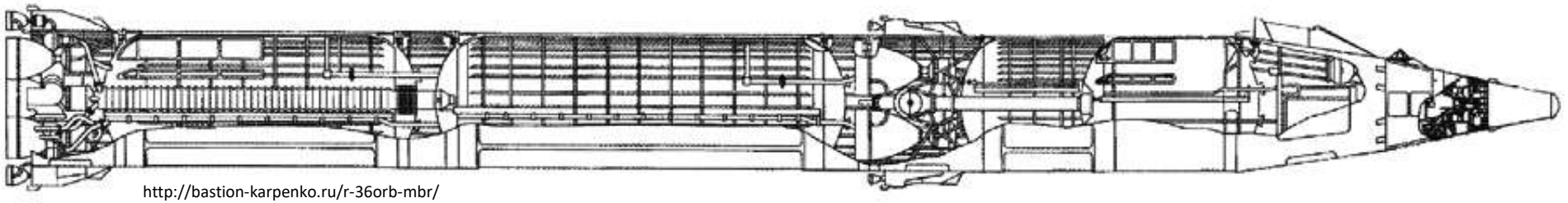
27 March 2019, PDV Mk-II, 300 km, T+ 168 s

Fractional Orbital Bombardment System (FOBS)

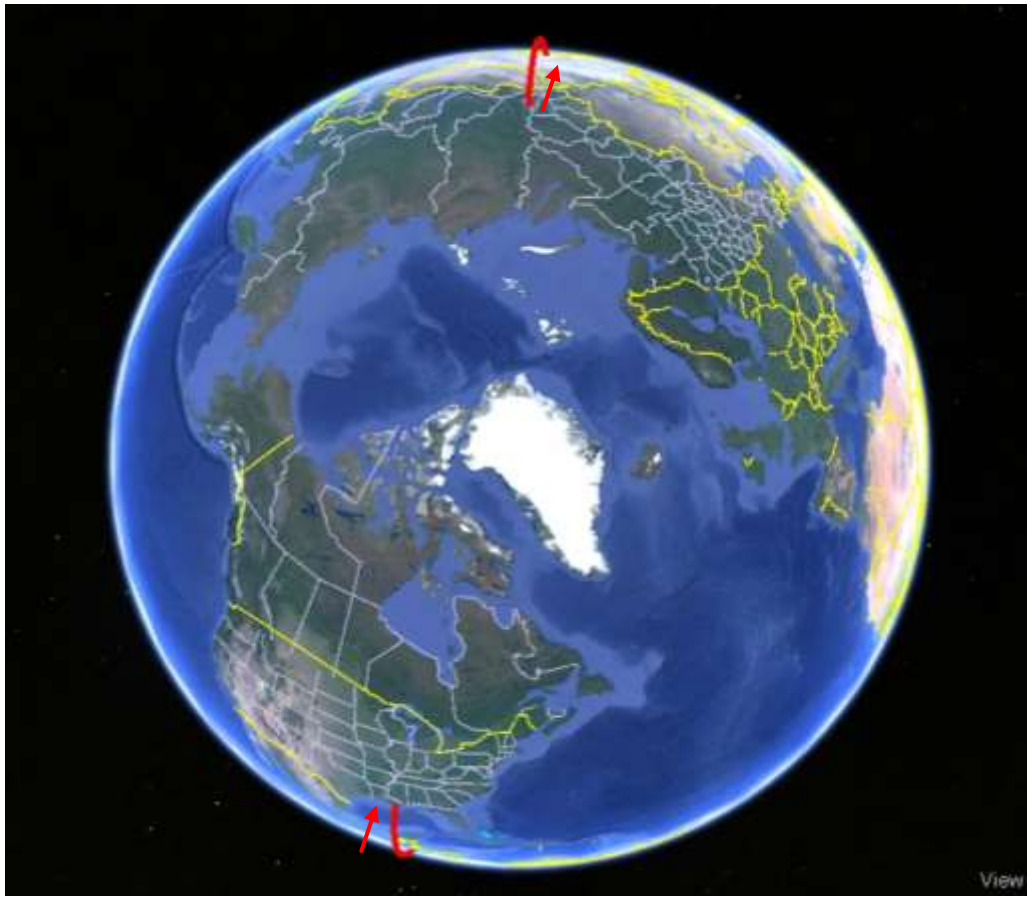
- Old idea (1950s)
- Soviet UR-500 developed for FOBS (became Proton SLV)
- 1969-1982 Soviet R-36ORB deployed
  - *182 t launch mass*
  - *150 – 180 km orbit altitude*
  - *orbital section mass 1,700 kg*
  - *single nuclear warhead (5 Mt TNT)*

https://rvsn.info/missiles/r_36orb.html





http://bastion-karpenko.ru/r-36orb-mbr/



Fractional Orbital Bombardment System (FOBS)

Sarmat ICBM (Russia) from Uzhur Silo Field to New Orleans.

Recent Revival of FOBS

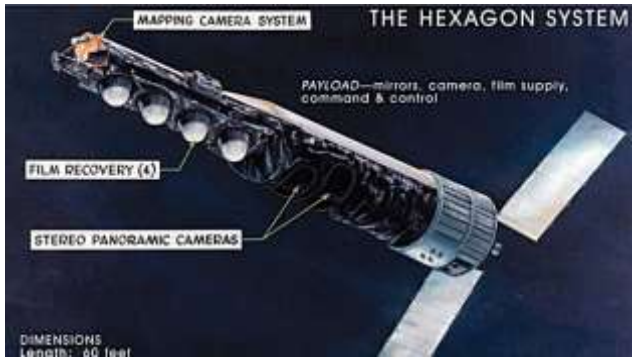
- Announced capability of new Russian Sarmat ICBM (to be deployed 2024+)
  - *successor of the SS-18/Satan ICBM, which was the successor of the R-36 ICBM*

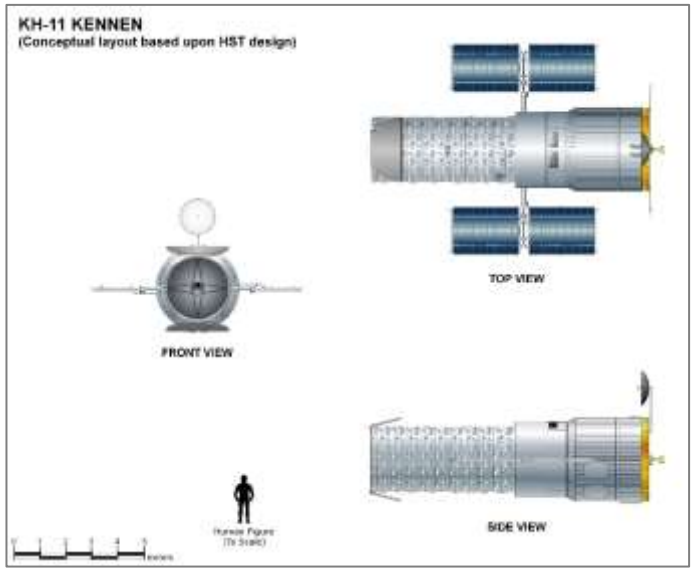
- Chinese "Orbital HGV" test of July 2021
  - *single orbit*
  - *impact after 100+ minutes*

„Military Satellites“

- Intelligence, Surveillance, Reconnaissance
- Communications
- (Command & Control)

- Been done since… forever!!!!





Polyus

- Soviet orbital weapons platform
  - *Megawatt-class carbon dioxide laser*
  - *80 t launch mass*
- Launched 15 May 1987
  - *orbit injection failed*

MMX ICBM Basing Options (1981)

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ICBM BASING OPTIONS:
Defense Department Survey†

PAGE 6 THE CENTER FOR DEFENSE INFORMATION

ORCA

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WIDE BODY JET

Description:

- New booster in Minuteman silos
- On warning, launch weapons into orbit
- On command, deorbit to attack or recover

ORBITAL BASED

Positive Features:

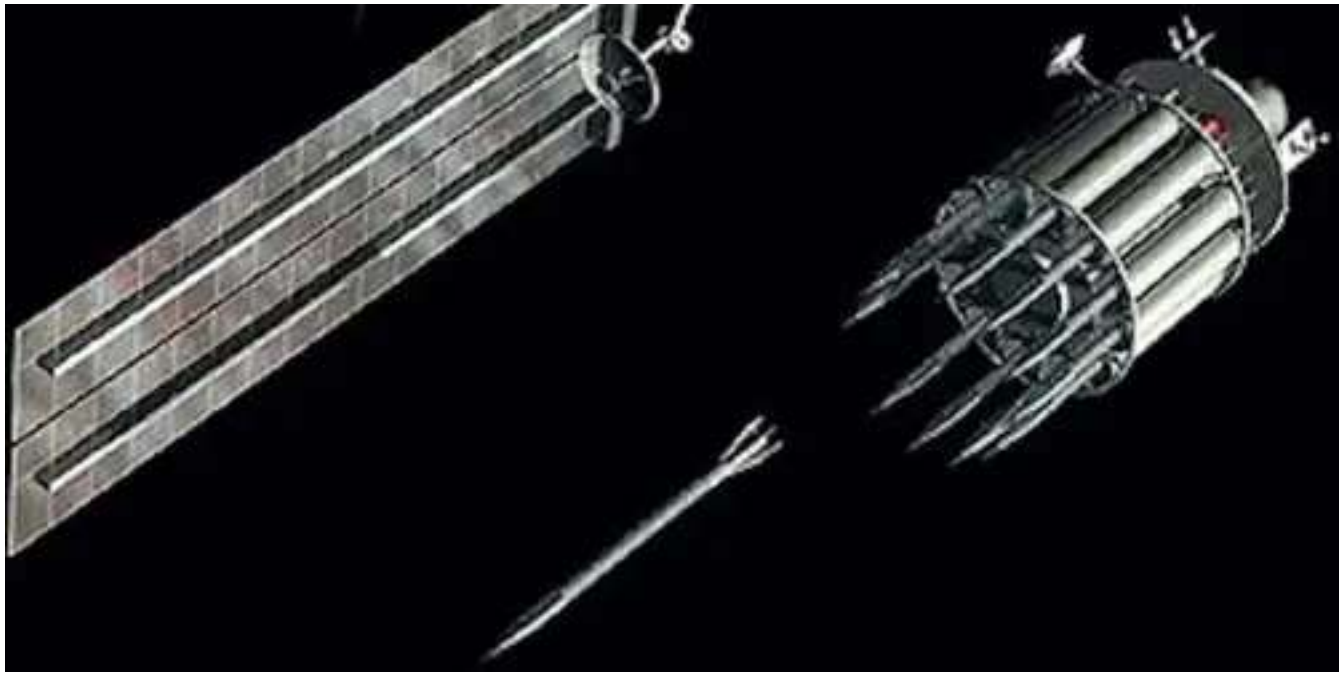
- Low cost

Negative Features:

- Vulnerable to attack in orbit
- Requires warning
- Accuracy insufficient for hard targets
- False alarm means loss of capability
- Orbital weapons violate space treaty

"Rods from God"

- 1950s: "Project Thor"
- 1980s: "Brilliant Pebbles"
- 100s of Tungsten Rods in Orbit
  - *7 m long*
  - *0.3 m diameter*
  - *Mach 10 at impact*
- Problems
  - *12 t per rod ($240+ million just for launch to orbit)*
  - *Accuracy*
- Revisited 2003



The Real Headache

SPACENEWS

Maneuvering Russian Satellite Has Everyone's Attention

by Mike Gruss — July 17, 2015

Russian "Rokot" launch. Credit: Ministry of Defence of the Russian Federation

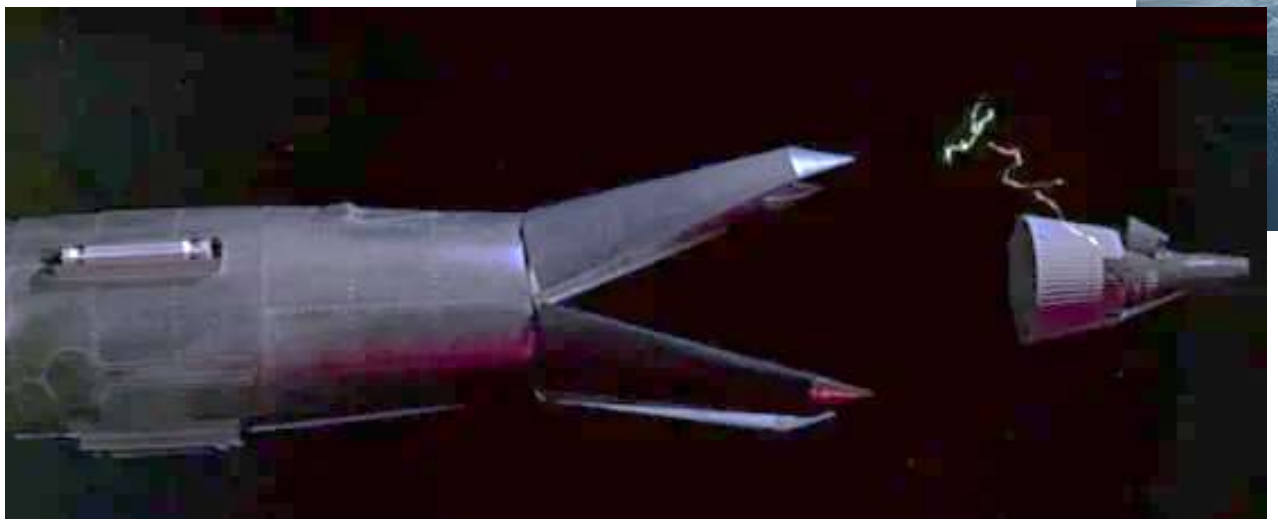
WASHINGTON – A Russian military satellite launched in March has made at least 11 close approaches to the rocket upper stage that released it into orbit, according to a spokesman for the U.S. Air Force.

Such maneuvering capability is consistent with, but not necessarily indicative of, an on-orbit anti-satellite weapon.

Rendezvous Operations with Non-cooperative Targets

- Cleaning Space Debris
- Attacking Satellites

ESA – ClearSpace-1(2026)



James Bond – You Only Live Twice (1967)

Exemplary Problem

Russian satellite Cosmos 2542 *and US satellite* USA-245 *in winter 2019/2020*

Object Action	Date Time	Inclination [°]	Orbital Period [min]	Perigee [km]	Apogee [km]
Cosmos-2542	26.11.2019	97.902	96.95	368	858
Cosmos-2543 detaches from 2542	06.12.2019	97.895	96.95	368	858
Cosmos 2543 raises orbit	mid 12.2019			+55	
USA-245 leaves this orbit	9./10.12.2019			272	985
Cosmos-2543 raises to	early December			590	859
USA-245	23.01.2020	97.86	97.44	283	1002
Cosmos-2543	29.01.2020	97.9	99.3	586	861
Cosmos-2542	29.01.2020			369	915
USA-245	19.02.2020			269	1018
Cosmos-2542	24.04.2020	97.7	97.3	352	919

orbital differences 23.01.2020
0.55° 1 s

Exemplary Solution

- Switch from few massive assets to swarms!

New Problem

Conclusions

Conclusions

- "Weapons ins Space" has always been a problem
  - *transit (missiles), non-aggressive satellites (comsats, spysats)*
- "Weapons in Space" should look at:
  - *permanently deployed systems intended for aggressive actions*
  - *phrasing must be refined ("permanently", "aggressive actions")*

- Autonomous "Killer Satellites" pose a massive problem
  - *defense side: don't put all eggs into one basket*
    -> from few big GEO assets to many small LEO assets

- Worst Case Scenario: Initiate "Kessler Syndrome"
  - *cascade effect in low Earth orbit*
  - *could be achieved easily*

Thank You!