

“Pyongyang Nukes World’s Satellite Constellations”
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June 1, 2022

Scenario and assumption: Given a nuclear detonation (NUDET) in low-Earth orbit (LEO), significant to catastrophic effects will occur to satellites and humans in orbit. The residual nuclear effects will become trapped in “tubes” formed by the Earth’s magnetic field. The radiation and other nuclear effects will last upwards of 2-years. The resulting orbital debris—thousands of inoperable and uncontrollable satellites and spacecraft in LEO—will last years to decades.

Discussion and Long-term Implications.

A LEO Catastrophe

- Significant/catastrophic impact to satellites and systems in LEO
 - Thousands of operational satellites become debris (failure within days to months)
 - Loss of life on space stations (International Space Station, Chinese Space Station, and commercial station) and of tourists operating in LEO.
- Satellites in MEO and GEO impacted less than those in LEO.
- Devastating impact to LEO-reliant space economy (tens to hundreds of billions USD), which will last for decades.
- Will affect the international community (US, its allies, and rivals). Space and LEO are an international environment. A NUDET will effect all spacepowers, but will especially effect those most reliant on space, like the United States.
- Replenishment of failed or inoperable LEO satellites won’t solve the problem (NUDET effects lasting months to years).
 - States and commercial companies will be forced to place and operate satellites in higher LEO, where more radiation shielding is required (increases size and weight).
 - Post NUDET, commercial companies will seek out other orbital regimes, like MEO and GEO.
- The U.S. national security space community will need to design and launch replacement satellites in LEO, or seek other orbits in MEO or GEO.
- There will be a U.S. government focus on developing suitable technologies and systems to efficiently remediate orbital debris (but it won’t be possible to clean it all up).
- The residual orbital debris will potentially collide with other debris causing a cascading effect—debris creating additional debris (not necessarily a full Kessler Syndrome).
 - The orbital debris will slowly decay in orbit as atmospheric drag pulls the debris into the Earth’s atmosphere to burn up. This will take years to decades (or much longer), for all the LEO debris to decay and reenter the Earth’s atmosphere.

Impact to Transportation Industry

- Weather forecasting will negatively affected for years (2nd & 3rd order effects) until new satellites can be built and launched.

- The transportation industry (maritime, air, and land) relies heavily on the weather forecasting to optimize supply chain and logistical activities.
- Destroying LEO weather satellites (NOAA's polar weather satellites) will make weather forecasting less accurate, causing longer delays in the transportation industry.
- This effect and underlying cost is not well understood.

Loss of Life

- Loss of life to human working and living in space will likely elicit a response different from loss of robotic/unmanned space systems. The loss of life may be immediate (due to NUDET proximity) or be delayed by residual radiation and nuclear effects. A rough order of magnitude for loss of human life could be 20-30 people.
 - For hazards caused by orbital debris, astronauts will shelter in place in their recovery vehicle or capsule (Soyuz or Crew Dragon for ISS), which is docked aboard space stations.
 - Note: Since the arrival of the first permanent crew to the ISS in 2000, the emergency return capability has been fulfilled by Soyuz spacecraft and, more recently, SpaceX's Crew Dragon – each rotated every 6 months. However, there is not enough space to return a full contingent of crew aboard the International Space Station back to Earth. So in this NUDET scenario, not all crew members aboard the International Space could shelter in place or have an emergency way of return to Earth. A full crew return vehicle (CRV) has been talked about for decades but not funded.
 - There will be loss of life aboard commercial space stations and space tourist operating in LEO.
 - The international and domestic court systems will have to deal with the numerous lawsuits resulting from the NUDET.
- Countries that had an astronaut or citizen perish due to the NUDET may seek retribution through military means, thereby causing international instability and raising the potential for larger conflict.

A New Space Economy

- A new space economy will develop, focusing on debris removal and remediation, and remediation of NUDET effects in LEO.
- Those countries or commercial companies that get their satellite operating within the preferred high-LEO regions may re-sell their spots for profit.
 - The new space economy will include the need to place satellites in higher orbits (MEO or GEO) or higher LEO—regions with higher radiation because of the proximity to the lower portion of the Van Allen radiation belts. Operating in higher LEO will require additional radiation hardening (expense and weight).
- Because the other LEO orbits are “trashed” due to resulting debris from the NUDET and follow-on cascading conjunctions, the higher LEO orbits are considered a premium (orbital decay of debris lasting years).

- This new, higher LEO region will become a competitive marketplace. US and China and Russia will compete for any LEO orbits considered useable, potential increase in tensions. Countries and commercial companies will rush (potentially unsafely) to “get there first” to the higher LEO orbits. Some countries and companies may just launch satellites in a haphazard and unsafe manner.
- The underwriting industry will raise insurance premiums for satellites in LEO or for commercial companies reliant on LEO space services.
- Many companies in LEO go out of business.
- There will likely be a supply chain shortage of space qualified, radiation hardened integrated circuits, batteries, and other spacecraft components.
- Many less well-off countries will likely not return to putting satellites in LEO for decades.