

Small Satellite Space Traffic Management

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THE SHIFT FROM BIG SATELLITES TO SMALL ONES

- Historically, satellites were large and complex machines
 - Primarily for military applications
 - Carried large payloads
 - Optical telescopes
 - Antennas
 - Required large amounts of power
- Large satellites have many disadvantages
 - Expensive to place in orbit
 - Size limited by fairing of launch vehicle
 - Launch or on-orbit failure can mean loss of all capability

- Recent advances in technology have made it possible to miniaturize many satellite components, and in turn reduce the size of satellite dramatically
- This is being driven by several important factors
 - Greater interest in space capabilities by emerging/developing countries
 - Growth in civil, scientific, and academic space missions
- This change is also starting to happen with military satellites as well
 - A few, large satellites are very vulnerable to kinetic attacks
 - Shifting towards *distributed constellations* of many smaller satellites can deter kinetic attacks and increase survivability

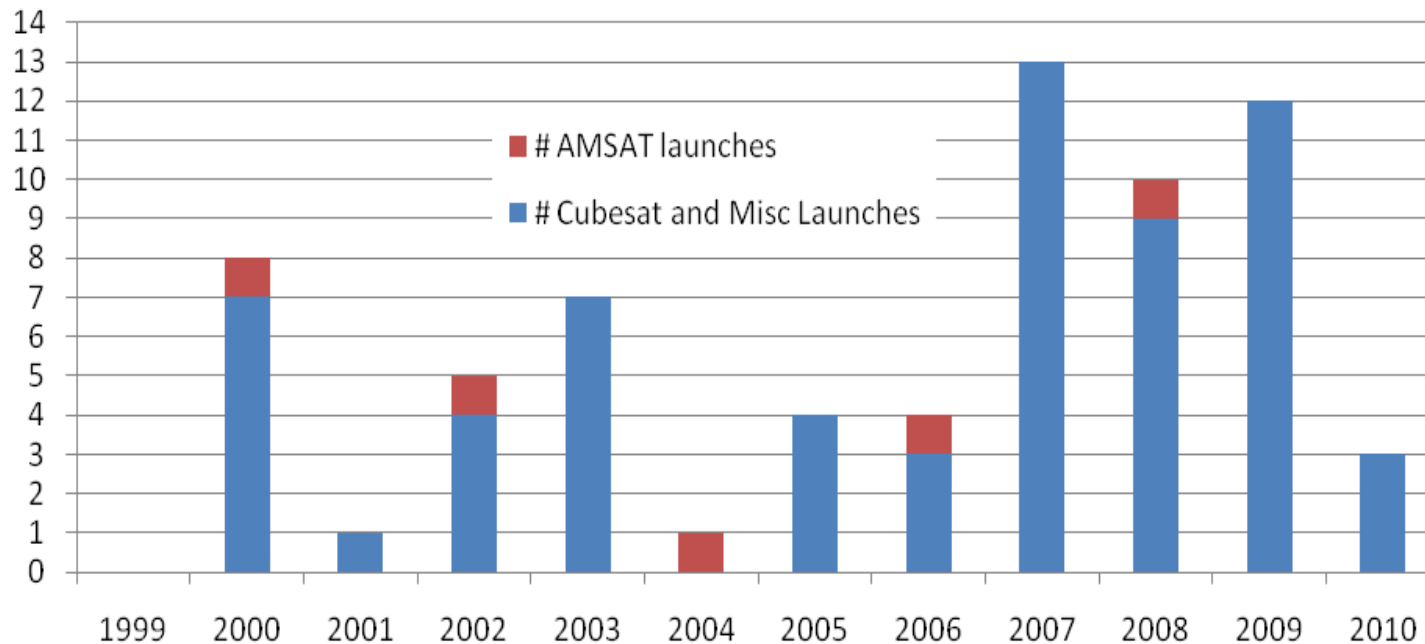


THE POTENTIAL RISK POSED BY ULTRA LOW MASS SATELLITES

Class	Weight
“Standard”	> 1000 kg
Mini	100 – 1000 kg
Micro	10 – 100 kg
Nano	1 – 10 kg
Pico	100 g – 1 kg
Femto	< 100 g

**“Ultra Low
Mass
Satellites”**

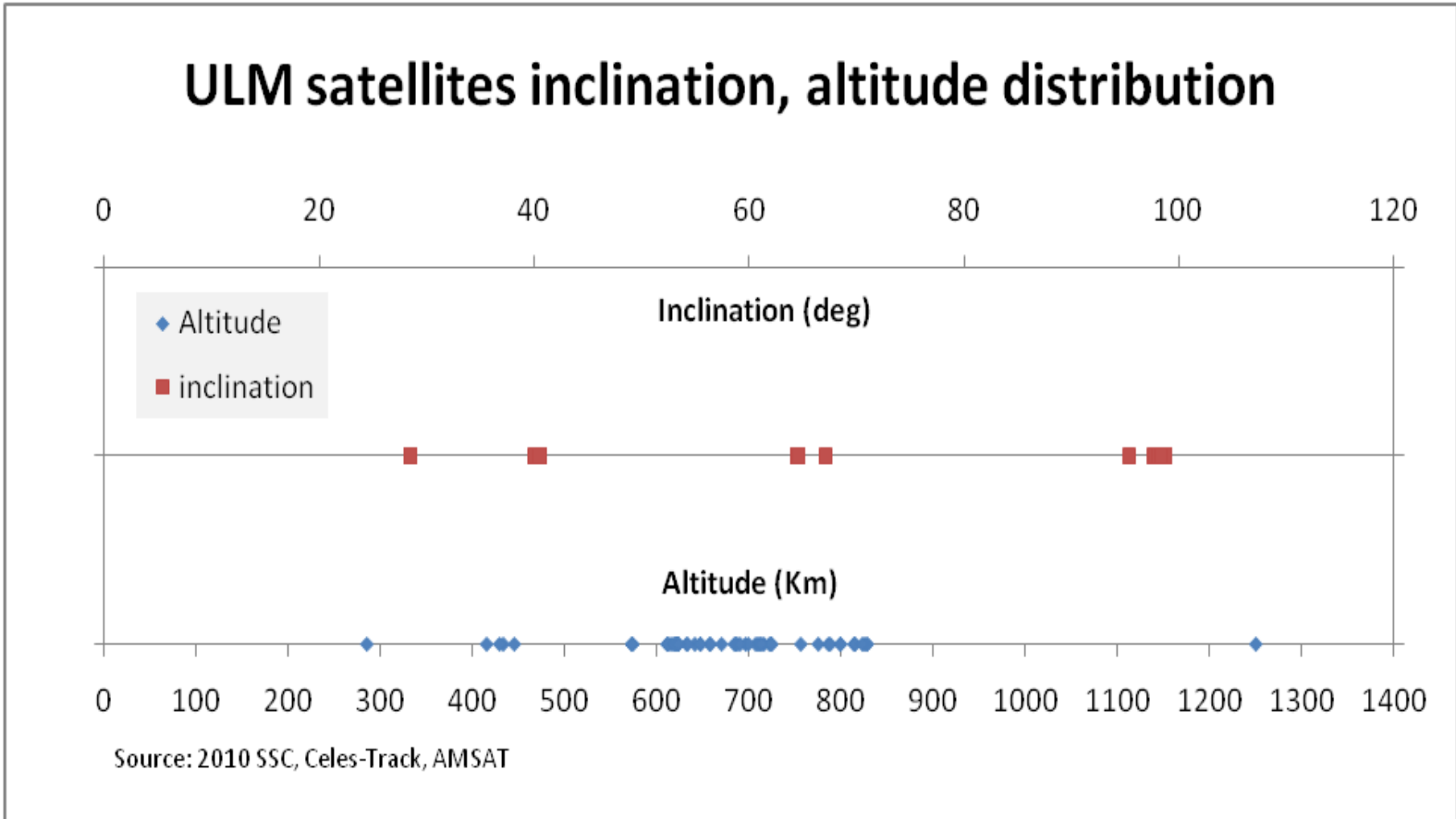
Ultra-low mass satellite launch frequency



Source: 2010 SSC, Celes-Track, AMSAT

Note: ULM, satellites of mass < 15 kg

Total on orbit as of 2010: **41**



- Difficult to track
 - Although some sensors can track objects below 10 cm in LEO, the major tracking networks cannot track objects below 10 cm reliably at this point
- Extreme power/weight constraints that preclude end-of-life de-orbit capability
 - De-orbiting requires fuel or significant electrical power, which many ULMs do not have
 - Not an issue if the ULM satellite is placed in a low orbit with a fairly high rate of natural decay
 - Significant issue if the ULM satellite is placed in Sun-Synchronous Orbit (SSO) or higher

- Orbit zoning / segregation
 - ULM satellites only allowed in certain regions?
 - “Protected Human zone” below 450 km?
- Mandatory de-orbit at end of mission life (instead of 25 years)
- Voluntary broadcast of positional data
 - Similar to airplane Identification Friend/For (IFF) squawk
- Mandatory tracking enhancement
 - Radar reflectors

- Yes, ULM satellites are hard to track and many may not have de-orbit or maneuver capability
- However, they are also smaller in size and lower in mass than traditional satellites
 - Smaller size means the probability of colliding with another object is lower
 - Lower mass means that any collision with an ULM satellite would result in a lot less debris generated.
- ULM satellites might actually have a net positive effect on the debris population growth and collision risk *if* they are launched instead of large payloads

SWF/BEIHANG/ISU RESEARCH PROJECT

- 3-year BUAA research project funded by Secure World Foundation
- Three main focus areas
 - Independent verification of the growth in the debris population and the need for active debris removal
 - Technical research and validation of active debris removal concepts
 - Research into small satellite space traffic management issues and potential techniques
 - Does a shift towards ULM satellites present an increase risk of collision and/or growth in the space debris population?
 - What are some potential mitigation techniques?
 - What are the advantages and disadvantages of these techniques from a technical and economic perspective?

Questions?

Thank you

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