Small Satellite Space Traffic Management

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THE SHIFT FROM BIG SATELLITES TO SMALL ONES

Historical satellite size

- 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

The shift to smaller satellites

- 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

RapidEye

THE POTENTIAL RISK POSED BY ULTRA LOW MASS SATELLITES

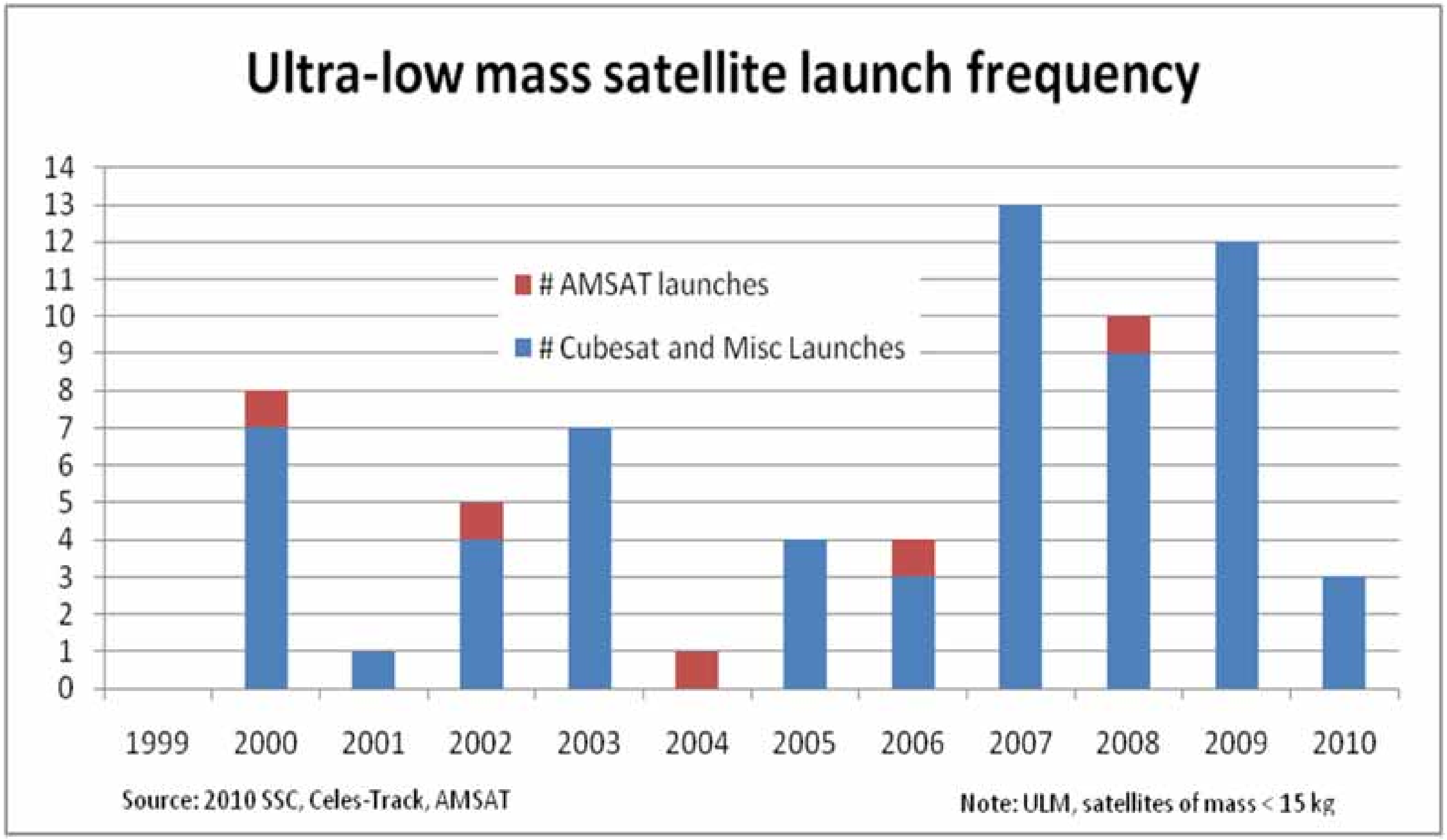
Classification of satellites by size

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"

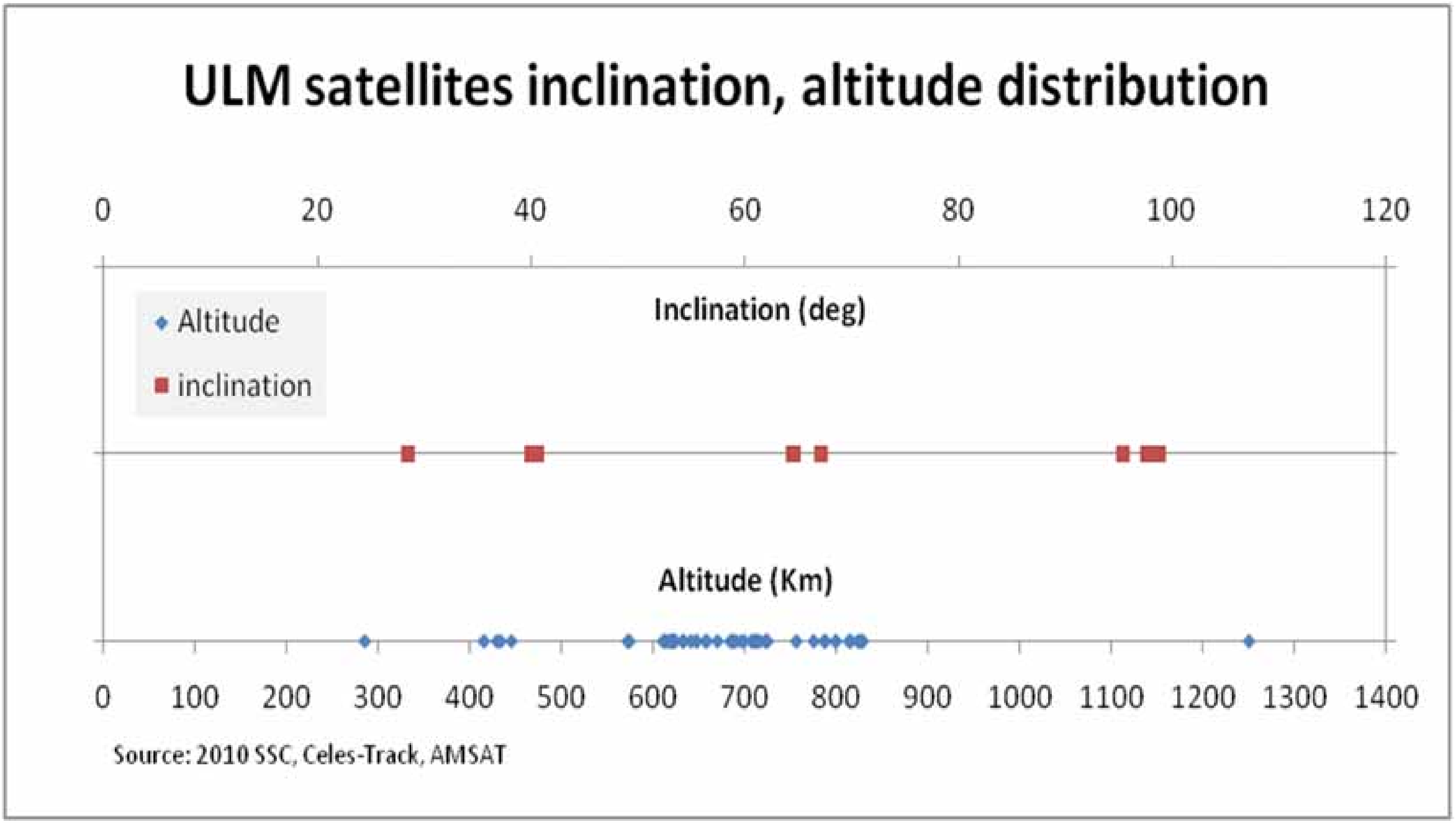
Launch history for ULM satellites

Promoting Cooperative Solutions for Space Security



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

Current locations of ULMs on orbit



Two major problems raised by ULM satellites

- 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

Potential solutions

- 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

Do ULM satellites actually pose a threat?

- 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

The 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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