

SFA Workshop on Regional Perspectives

Space Presentation

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Small Satellites (SmallSats)

- SpaceX Big Rocket
 - When built, among the largest rockets ever constructed
 - 100 ton payloads cheaply to Low Earth Orbit (LEO)
 - 1,000 MicroSats placed into proliferated LEO on single launch
 - Self-building '*LEGO*' kits that can build larger and more complex space satellites and stations than we know today
- One kilogram of stuff into space
 - 2004, 40K(\$US)/kg; 2018, \$2.5K/kg; 2020 \$47/kg
 - Can reusable rockets and 3-dimensional printing in space drive costs even lower?
- Decreasing costs catapults mom and pop space rangers into space realm and exponentially advances technology much like the internet did for computing

Proliferated LEO Constellations

- Trend toward constellations of many more smaller satellites in Low Earth Orbit (LEO)
- Motivations:
 - 100% global coverage, lower cost to build & launch, shorter life with faster technology refresh rate, higher constellation mission resilience if an individual satellite(s) were lost
- Current focus is global satellite communications (SATCOM)
- Planning and design of architectures for other mission areas ongoing:
 - Private and Military SATCOM
 - Broadband - Internet for All
 - Position, Navigation and Timing (PNT)
 - Missile Warning
 - Earth Imaging

Who's Who in Proliferated LEO

LEO & MEO Broadband Constellations

At least 15 companies have declared their intent to develop broadband satellite constellations in low Earth orbit (LEO) or medium Earth orbit (MEO), according to Northern Sky Research. Most of these companies intend to have their first-generation systems deployed within five years. O3b, which is nearing completion of a 20-satellite constellation begun in 2013, will add seven mPower second-generation broadband satellites starting in 2021.

PROGRESS KEY

- Constellation builder selected
- Launcher(s) identified
- Prototype satellite(s) launched
- Operational satellite(s) in orbit

Source: Northern Sky Research

SPACENEWS

Laser Light
Satellites: 12
Altitude (km): 10,000

LeoSat
Satellites: 108
Altitude (km): 1,432

Samsung
Satellites: 4,600
Altitude (km): 1,500-2,000

Lucky Star
Satellites: 156
Altitude (km): 1,000

SpaceX Starlink
Satellites: 4,425
Altitude (km): 1,100-1,325

Hongyan
Satellites: 300
Altitude (km): 1,100

Viasat
Satellites: 24
Altitude (km): 8,200

OneWeb
Satellites: 900
Altitude (km): 1,200

Yaliny
Satellites: 135
Altitude (km): 600

Astrome Technologies
Satellites: 600
Altitude (km): 1,400

Xinwei
Satellites: 32
Altitude (km): N/A

Telesat LEO
Satellites: 117
Altitude (km): 1,000

Boeing V-band
Satellites: 2,956
Altitude (km): 1,030-1,080

Comsat
Satellites: 800
Altitude (km): 600



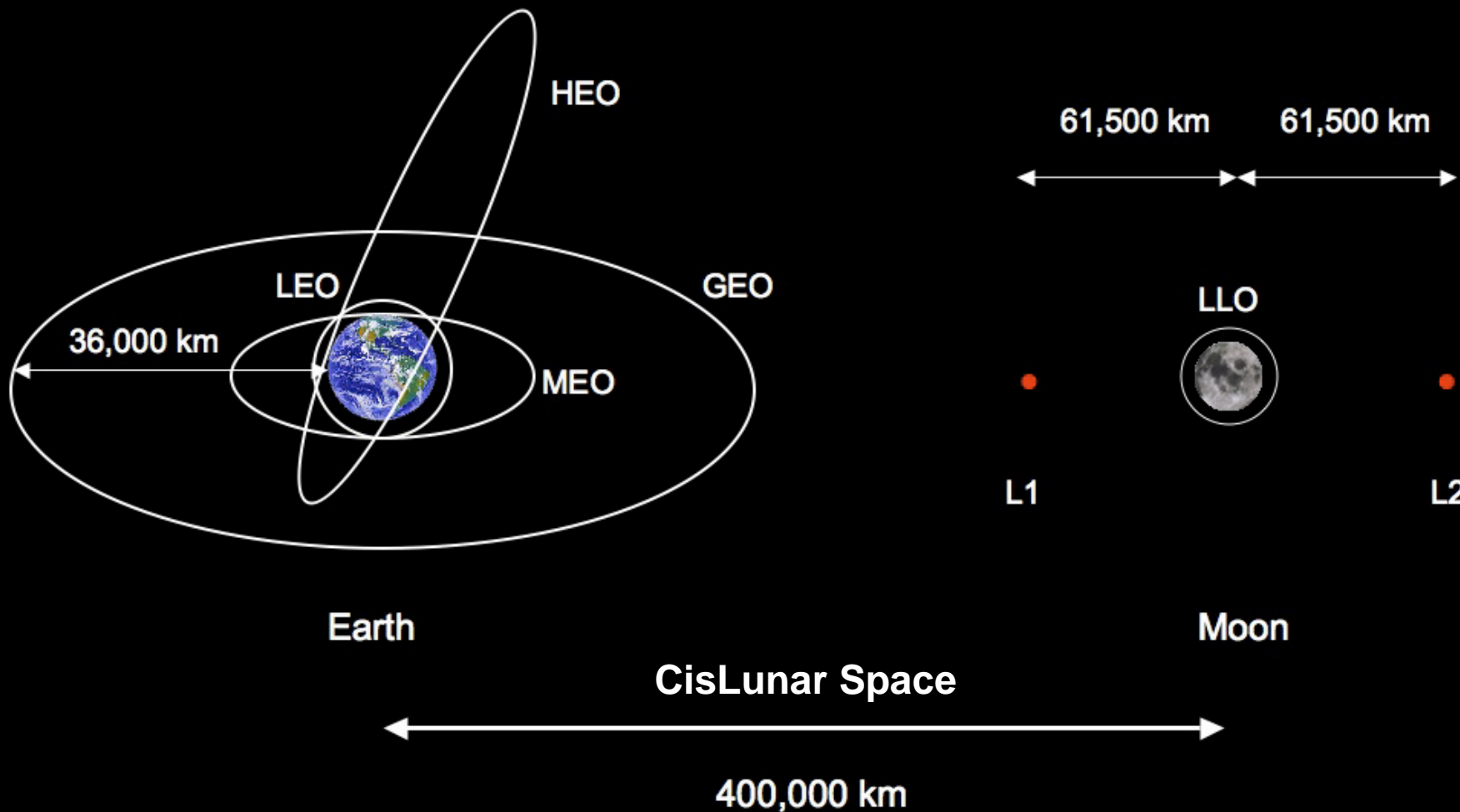
SATCOM Internet

- Uncensored access to the internet
 - Governments attempting to block access may cause unintended denial to other space-based services
 - How would attempting to jam private satellite communications (SATCOM) internet providers be interpreted by the global community?
- Remote locations
 - Isolated communities can become part of the global collective awareness
 - Economic advances in rural areas
 - Retard population migration to mega cities

Space Travel

- REMINDER: Only several decades separated manned flight from manned orbit
 - Rapidly developing rocket engine technology will cause the cost of access to space to plummet
- Virgin Galactic is poised to take paying customers on up and back space adventures
- Blue Origin's 'New Shepard' re-usable launch vehicle can feasibly usher in the age of a space hop
 - Modify the capsule to enable the launch vehicle for transport of humans from GBR to AUS in 2 hours or so
- SpaceX has plans for circumlunar space travel

Orbits Above GEO (Cislunar)

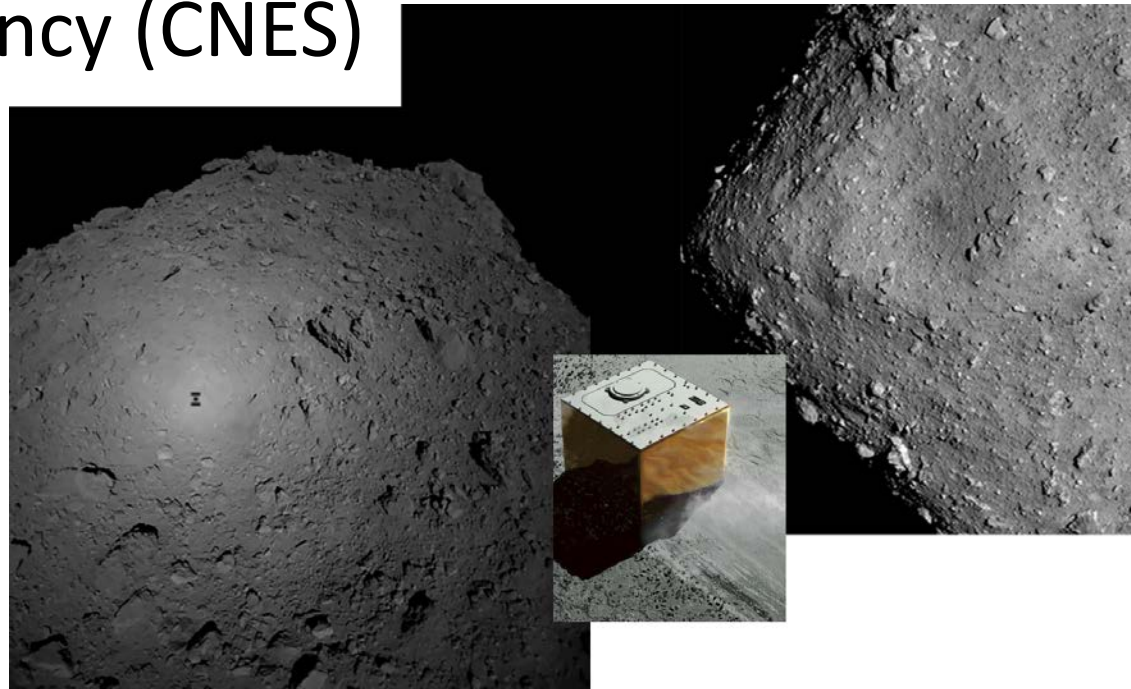


Cislunar Orbits

- Considerable interest in exploring beyond geostationary orbits (GEO)... but why?
 - Return to the Moon
 - Solar Observation
 - Access to non-Earthbound resources to enable further space travel
 - Asteroid mining
- How will regular and prolonged human presence on the Moon and its orbital region influence human activities on Earth?
- Will international competition for resources and military advantage extend here?

Asteroid Landing

- Japan Aerospace Exploration Agency (JAXA), German Aerospace Center (DLR), French space agency (CNES)
- Landed Oct 2018



Collection & Recycling

- Asteroid mining for rare earth materials
- By comparison, moon mining is technically simpler
- Space debris pickup
 - Materials can be recycled on Earth for monetary gain
- Opportunities for scientific community and private entities to profit

GPS Reliancy

- Global Positioning System (GPS) is easily jammed or spoofed
- Operating in a GPS-denied environment is highly likely to be a future reality for the Alliance
- The general public is addicted
 - Tell me again how I get to Grandma's house?
- Position Navigation and Timing (PNT)
 - Essential to banking industry and identifying when transactions take place
 - Necessary as well for our state of the art energy systems
- Possible to use commercial transmissions (WiFi, mobile phone towers, etc.) to geo-locate in the absence of Satellite Navigation (SatNav) data

Imagery Intelligence

- Commercial optical images already exist but they're regulated by space agreements
 - What will happen when unregulated commercial entities and non-state actors enter the scene?
- Observing from space in other wavelengths is more difficult yet doable
 - A decade ago synthetic aperture radar images required supercomputers to process imagery. Now the same computing power is carried in most people's pockets

Militarization of Space

- “Space Force”
 - Does it provoke increasing military activity in space from other actors?
- Usage of anti-satellites
 - Kinetic, ground-based methods are frowned upon due to large amounts of debris caused
 - Non-destructive options however...
 - Sails, nets, propulsion modules, passive and active tethers
 - Can even deorbit assets to collide with a target