Delimitation and Commercial Use of Outer Space

Sang-Myon Rhee Seoul National University March 28, 2011

Where to Delimit ?



Atmospheric gases scatter blue wavelengths of visible light more than other wavelengths, giving the Earth's visible edge a blue halo. At higher and higher altitudes, the atmosphere becomes so thin that it essentially ceases to exist. Gradually, the atmospheric halo fades into the blackness of space.

Problems & Issues

- Problems in Traditional Delimitation
- Air Space
- Outer Space
- Necessity or Non-Necessity?
- Issues in Commercial Uses
- In the Air Space
- In the Outer Space

Kinds of Delimitation

- Boundary of the Surface?
- Boundary of the Plane?
- Boundary of the Column?
- Boundary of the Cube?

Superjacent Coelum Spaces

• Air Space

- Sovereignty under National Laws
- *Res communes* under International Law
- Outer Space
- Activities under National Law & Policy
- *Res communes* with International Law
- Contiguous Space ?
- Safety Interests
- Security Interests

Necessity or Non-Necessity?

- No Present Need Theory
- Bin Cheng: "It should be left to scientists to solve at later date."
- Functional Approach for S. Activities
- Aerodynamic Lift Theory
- Lowest Point of Orbital Flight Theory
- Contiguous Column Theory: Rhee

Where's the Boundary?



Karman Line

- 100 Km (= 62 Miles) above sea level
- Federation Aeronautique Internationale
- Theodore von Karman (1881–1963)
- "Edge of Space": atmosphere becomes too thin for aeronautical purpose
- 3 Nasa X-15 Pilots flew 90-108km in 1960s: They were awarded astronaut wings retroactively in 2005

A Contiguous Space?

- Air Space
- From the sea-level up to 50km
- National Law + International Air Law
- Contiguous Space
- From 50km up to 100km
- Innocent Passage for Security Interests

Expendable Launch System

- History
- 1950s-era: Ballistic Missile Technology
- Shuttle Orbiter -> Semi-Reusable
- European Sponsorship
- American Deregulation
- Russian Privatization
- American Subsidization
- Launch Alliances

Reusable Launch System

- Partially Reusable Shuttle:
- Single Stage to Orbit (SSTO)
- SSTO Vertical Launch Vertical Landing
- SSTO Horizon Launch Horizon Landing
- SSTO Vertical Launch Horizon Landing
- SSTO Horizon Launch Vertical Landing
- SSTO: Reagan (1986): NASP/X-30

Reusable Concepts

- Single Stage to Orbit (SSTO)
- 2 or More Stages to Orbit
- Horizontal Takeoff or Vertical Takeoff
- Horizontal Landing or Vertical Landing
- Air-breathing
- Propellant
- Launch Assistance
- Reentry Heat Shields

Orbital Reusable Launchers

- Space Shuttle (Partially Reusable: PR)
- USSR Energia-Buran(PR: Cancelled)
- Planned: SpaceX Falcon 1 (PR)
- Planned: SpaceX Falcon 9 (PR)
- Planned: PlanetSpace Silver Dart (PR)
- Planned: Reaction Engines Skylon (Proposed Air-breathing SSTO Spaceplane)

Space Transport

- Propulsion: Rocket Technology
- Expendable Launch System
- Single Stage to Orbit (SSTO)
- Orbital Maneuvering System
- Interplanetary Travel
- Interstellar Travel
- Intergalactic Travel

Constellation Program (CxP)

- A Human Spaceflight Program: NASA
- Exploration Systems Architecture Study
- Obama: Proposed to Cancel C Program
- Spacecraft
- Orion CEV (Crew Eploration Vehicle)
- Altair
- Earth Departure Stage

Space Act Agreements (US)

 Commercial Orbital Transportation Services (COTS)

 Commercial Crew Development (CCDev)

Spaceplane

- Description: Aerodynamic Lift
- Atmospheric Reentry
- Propulsion: Rocket Engine Air-breathing

- Surface to Surface (STS)
- Episode of U-2
- Surface to Outer Space (STO)
- Surface to Outer Space to Surface (STOS)

Flown Spaceplanes

- Orbital Spaceplane: VTHL
- Suborbital Spaceplanes: X-15, SpaceShipOne, ASSET
 Scaled Composites & Virgin Galactic Unveiled in 2009 SpaceShipTwo, VSS Enterprise, WhiteKnightTwo Mothership 'Eve'

VentureStar

Space Elevator

- Geostationary Orbital Tethers
- =Orbital Space Elevator =beanstalk
- Structure
- Base Station
- Cable
- Climbers
- Powering Climbers
- Counterweight

Space Elevator



Elevator Platform



tethered to a mobile seagoing platform.

Space Lift



Space Lift Pods



Space elevator pods

Space Elevator



Space Elevator Theory



Commercialization of Space

- Satellite Communication:
- Satellite Subscription Services: DirecTV
- Transponder Leasing: Lease or Sell
 Access to it to data relay & telecom firm
- Ground Equipment Manufacturing: Uplink & Downlink Terminals, Mobile Satellite Phone Units, etc.
- Commercial Satellite Manufacturing

Satellite Imagery

- Uses: agriculture, geology, forestry, biodiversity conservation, regional planning, education, intelligence, war
- Resolution and Data
- GeoEye
- DigitalGlobe
- Spot Image
- RapidEye
- ImageSat International

Satellite Navigation

- Global Navigation Systems
- Civil and Military Uses
- Operational
- GPS
- In Development
- GLONASS
- Compass
- Galileo

Space Tourism

- Russian Space Program
- For the Purpose of Personal Pleasure
- Virgin Galactic
- SpacePorts

Virgin Galactic



Virgin Galactic



Virgin Galactic



Virgin Galactic (Spaceport)



Virgin Galactic (Spaceport)



High Altitude Platforms(HAP)

- A Quasi-Stationary Aircraft which provide means of delivering a service while staying 17-22 km for some years
- It can cover smaller area effectively.
- It can be a manned, unmanned aeroplane, balloon, or an airship.
- A Strato-System HAP: up to 50 km?

HAPS



Figure 4 Wireless coverage area for a stratospheric HAPS

HAPS Network



Figure 2 Network architecture for a HAPS providing fixed wireless communication services

StratoComm TTS to STS



Figure 5 Transition from TTS to STS

Transitional Telecom System



Figure 3 Tethered transitional aerostat system

HAPs in Africa



Figure 1 Illustration of an aerostat-based HAPS over an African city

HAPs



Conclusion

- Air Space Commercial Use
- Space Tourism
- HAP
- Contiguous Space Security & Safety
- Innocent Passage
- Safe Entry
- Outer Space Commercial Aspects

Thank You!

