

NearSpace Traffic Management – A concept to accommodate hypersonic flights

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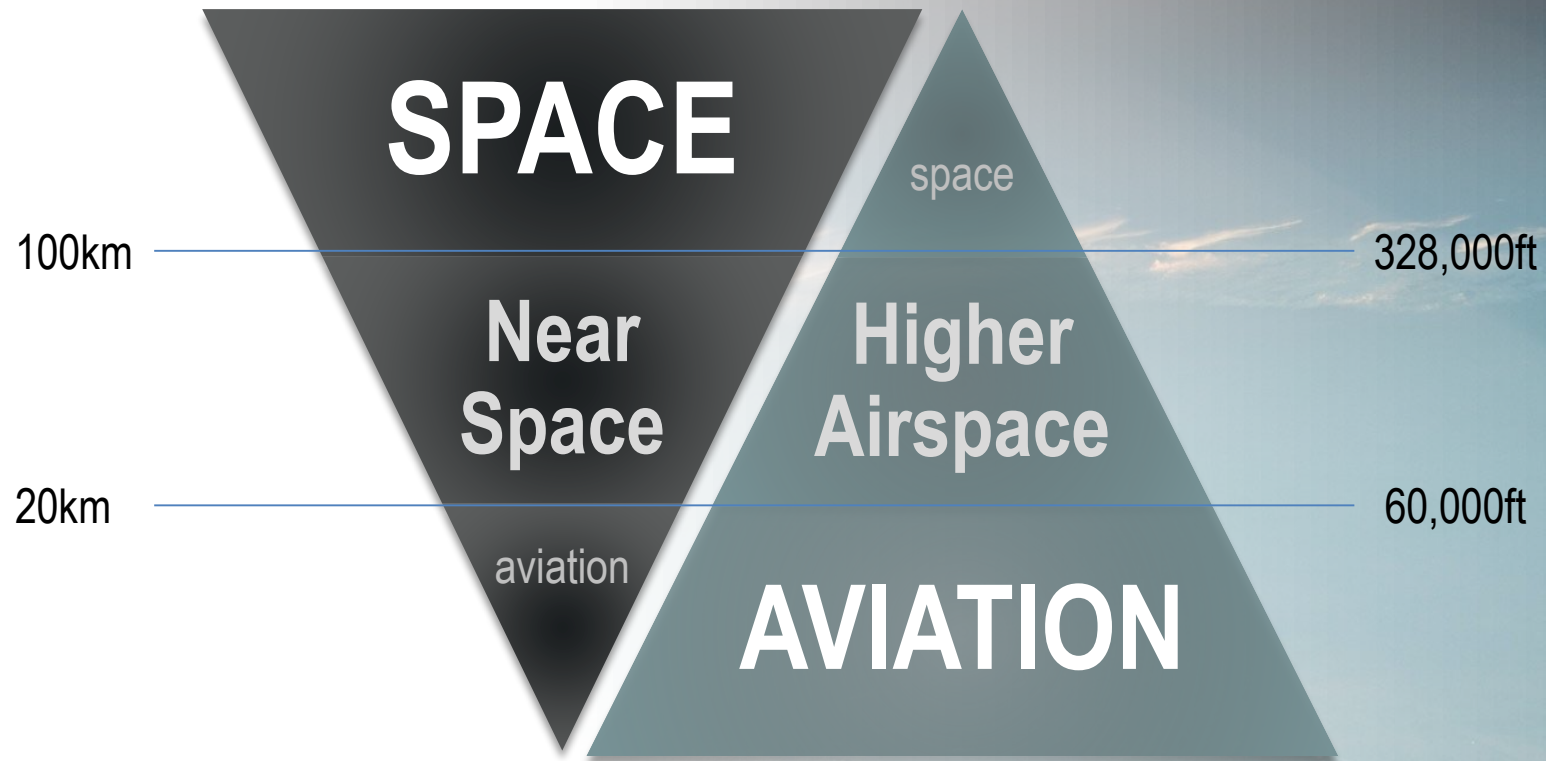
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Knowledge for Tomorrow



Challenges of NearSpace region



Challenges of NearSpace region

Solar Powered HAPS

High Altitude Balloons, Airships

Suborbital Space Flights

Launcher, Spaceships

Operational altitudes approx. 60.000 - 90.000ft

300.000 ft

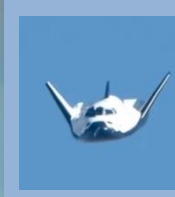
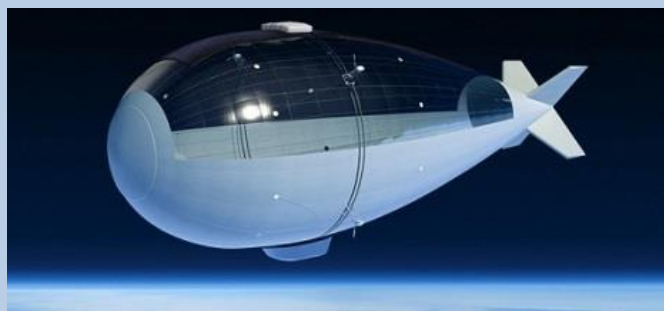
200km+

Communications
Technology demonstrations

Science
Surveillance

Edge of space tourism / manned flights
Launch platforms

Space transport
Satellites, Capsules, Orbiter



Challenges of NearSpace region

Users of the NearSpace region

- **Transit users**
those operations that transit the airspace vertically, including space launch and re-entry operations.
- **Persistent users**
those users for which the airspace is the destination from which services will be provided to the Earth, this includes high altitude long endurance unmanned aircraft
- **Point to point users**
those users that traverse the airspace while providing transportation between two points on the Earth.



Challenges of NearSpace region

Conditions in the NearSpace region

- Aircraft have met transit requirements to controlled airspace. Allows services without new mandates.
- Free from obstructions or terrain.
- Airspace above FL 660 is currently uncongested, allowing for the use of large separation standards as safety mitigation.
- Aircraft closely monitored by ground operator with infrastructure designed to conform to planned routes and altitudes
- Shared information on position, altitude, and trajectory can be used for collision avoidance purposes and for planning conflict-free routes,

NearSpace traffic management requirements ... and how to address them

Safe Operation

- Safe separation between all vehicles
- Large speed differences
- Tactical control becomes ineffective
- Maintaining separation becomes a strategic effort

- *Ensure safe operations at all times*
- *Plan operations to be conflict free*
- *Allocate appropriate operating zones*
- *Monitor operated flights*
- *Ensure Surveillance*
- *Supply interfaces to STM and ATM*

NearSpace traffic management requirements ... and how to address them

Strategic Separation

- Plan operation ahead in time to remain conflict free
- Consider different types of operation
 - short duration/high speed flights with inherent time uncertainties
 - long duration flights over relevant area of interest

NearSpace Operation Management System (NOMS)

- Route and schedule approved as free of conflict
- Augmented by tactical monitoring
- Mission assurance provided for long term planning
- Ensure also transfers to be free of conflicts
 - in airspace below FL660 and
 - into Earth orbit

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NearSpace traffic management requirements ... and how to address them

4D Operating Zone concept

- Uncertainty of aircraft position over time
- Modelling of route as operating zone
- Defined as a four dimensional shape and volume
- Varies based upon performance characteristics and mission design

Operating Zone planning

- Changes over time are part of flight planning process
- Changes occurring during operation
 - by external factors (weather, equipment failure, ..)
 - by mission requirements
 - due to de-conflicting measuresto be covered by NOMS processes and services.

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NearSpace traffic management requirements ... and how to address them

Monitoring tasks

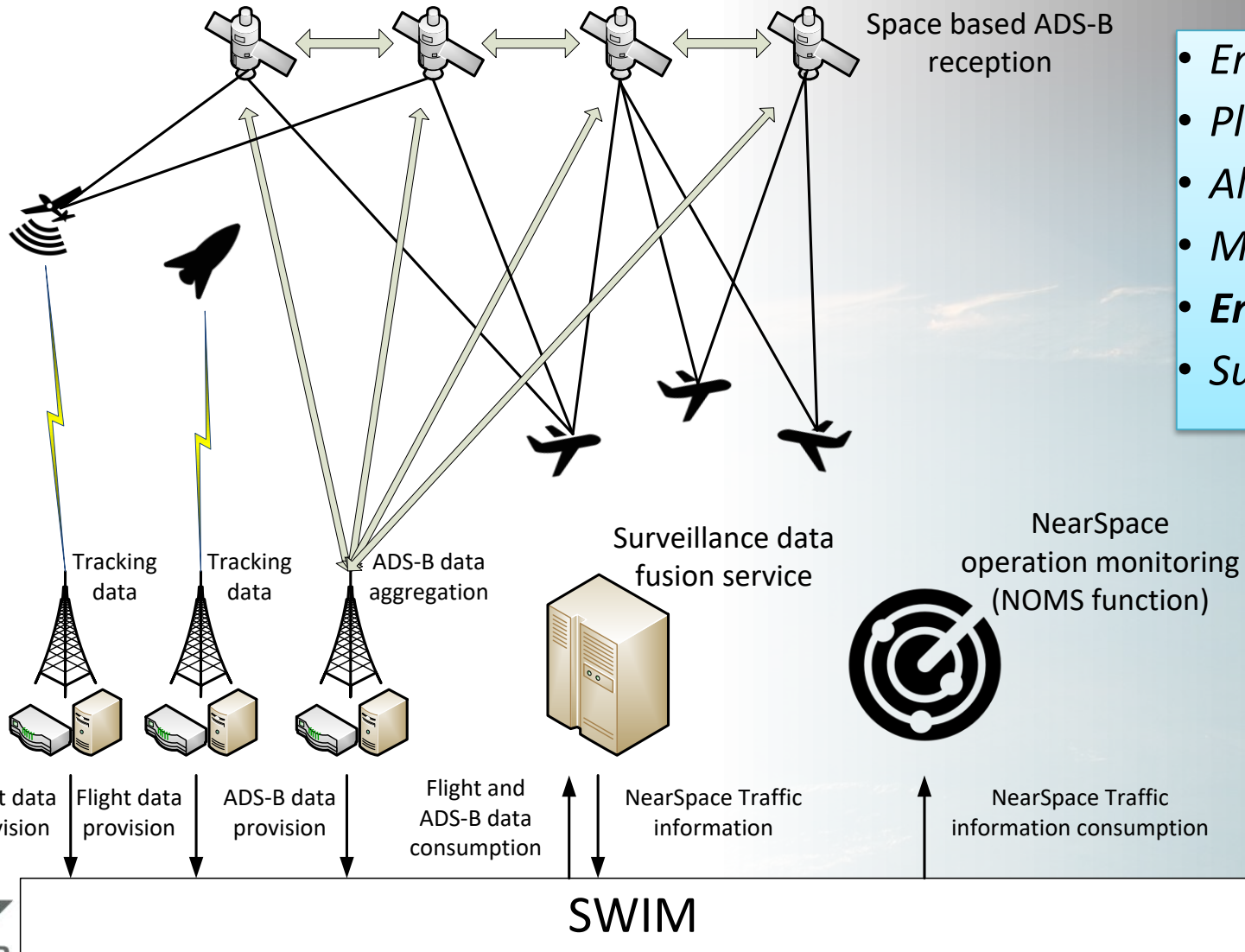
- Monitor vehicles along route and schedule clearance
- Ensures vehicles remain operating free of conflicts
- Changes to designated routes and operating zones checked against planning for related time of operation
- Inflight modifications and ad hoc change requests coordinated by operators in charge using the NOMS
- Adapt concept of flight centric ATM and ATC

Infrastructure and Data provision

- Utilize ground operator infrastructure
- Use of vehicle state vector, status data and flight planning information
- Data provision facilitated by SWIM based services

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NearSpace traffic management requirements ... and how to address them



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NearSpace traffic management requirements ... and how to address them

ATM interfacing

- Transit between NearSpace and airspace below FL660 to be coordinated
- Consider flight planning requirements of both domains
- Flight plan and status information sharing via SWIM
- Adapt existing data exchange formats (e.g. FIXM)

STM interfacing

- Ensure conflict free trajectory clear of interference with other space objects during planning phase
- Updates on position and status for re-entering vehicles
- On-time transfer of flight information to be established (e.g. incorporating runtime infrastructure of SWIM)

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- ***Supply interfaces to STM and ATM***

Commonalities between ATM and STM

ITU's orbit and spectrum allocation principles

- To avoid harmful interference
- To ensure efficient, rational and cost-effective utilization radio-frequency spectrum and satellite-orbit resources
- To develop procedures that facilitate access to the resources
- To establish global standards and associated material to assure the necessary required performance, interoperability and quality

ICAO's Air Traffic Management principles

- To prevent collisions between aircraft
- To expedite and maintain an orderly flow of air traffic
- To provide advice and information useful for the safe and efficient conduct of flights
- To establish global standards and recommended practices in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector

Merging the principles of both domains

- Basis for principles for the safe, efficient, rational and cost effective utilization of the NearSpace region. These principles are needed whether or not a state chooses to provide air traffic services above 20km. These principles would be to:
 - Avoid harmful interference
 - Prevent collisions between operators in the NearSpace region
 - To provide advice and information useful for the safe and efficient conduct of flights
 - To develop procedures that facilitate access to the resources
 - To expedite and maintain an orderly flow of air traffic
 - To establish global performance, interoperability and quality to provide a safe, efficient, secure, economically sustainable operating environment from 20km to 100km.

Summary

- **Major challenge: Diversity of operational types and mission profiles**
Three types of users: Transit – Persistent – Point to point
- **Concept Approach: Strategic separation to ensure safe operations at all times**
 - Plan free of conflict regarding route and schedule
 - 4D Operating Zone cover performance- / mission type uncertainties
 - Tactical monitoring augments strategic separation process
 - Multi-source surveillance approach
 - NearSpace Operation Management System (NOMS)
 - ATM and STM interfacing facilitated by SWIM based services
- **Provision of NearSpace services does not require new mandates**
 - Merge STM & ATM principles as NearSpace regulation framework
 - Allow operators to fly without tactical intervention by ATC

For further details see:

- Kaltenhäuser, S., Stilwell, R.; **The NearSpace Interface between Air and Space Traffic Management.**
IAC-18,D6.3.3, 69th International Astronautical Congress 2018, IAC 2018.



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Thank you for listening!

