Air Traffic Management and Space Transportation

System Wide Information Management and Integration into European Airspace

Sven Kaltenhäuser
Frank Morlang, Jens Hampe, Dirk-Roger Schmitt
German Aerospace Center DLR

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DLR

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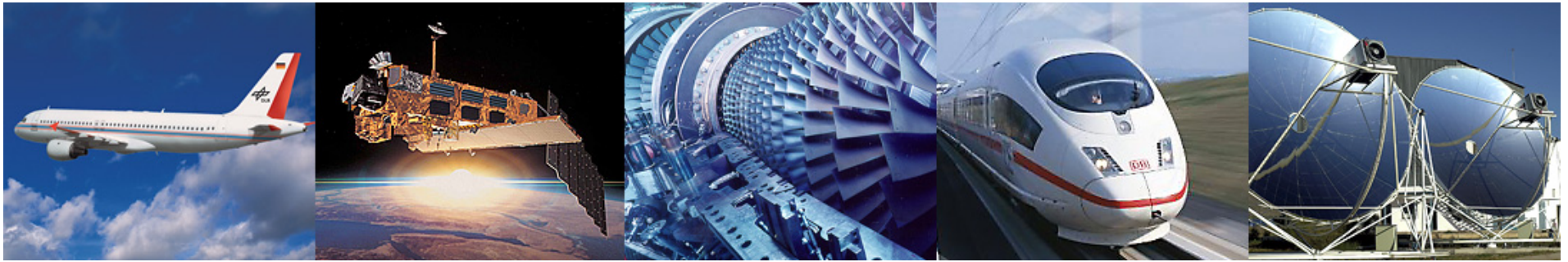
Overview

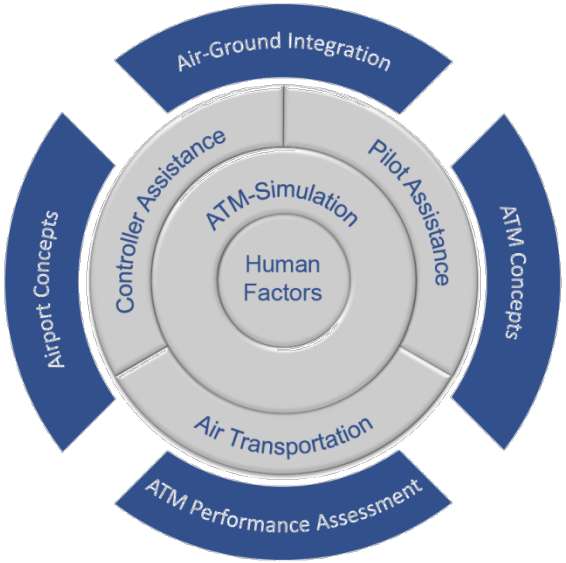
- German Aerospace Center DLR
- Handling Space Vehicle Operations in ATM
- SWIM Services integrating SVO into ATM

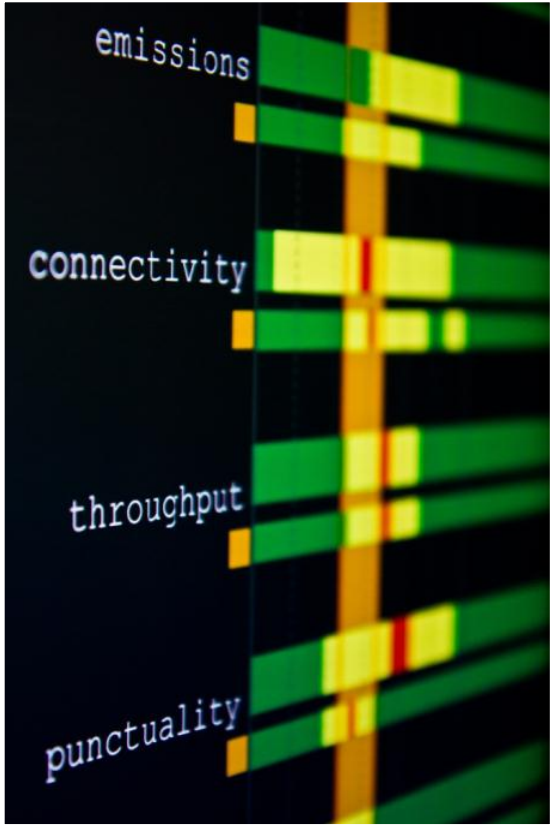
DLR – German Aerospace Center



- Research Institution
- Space Agency
- Project Management Agency

The DLR Institute of Flight Guidance

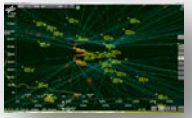




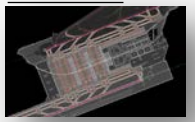
The DLR Air Traffic Validation Center

Modelbased Tools

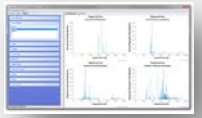
TrafficSim



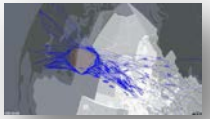
SIMMOD



Pre-/Post-Processing



AirTop



Smallscale Simulation

Real-Time (HIL) Simulators

Tower-Simulator

ATC-Simulator

Ext. Simulators

TowerLab

Flight-Simulator

ControlCenterSim.

External Testbeds

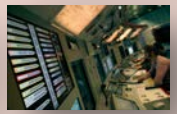
ARIF Hamburg

Ext. Aircraft

Ext. Towers

Ext. Airports

Ext. ATC Centers



Airport Research Facility

Datalink

RTO-Cameras

MLAT / WAM

GBAS

DLR Research Aircraft

DLR

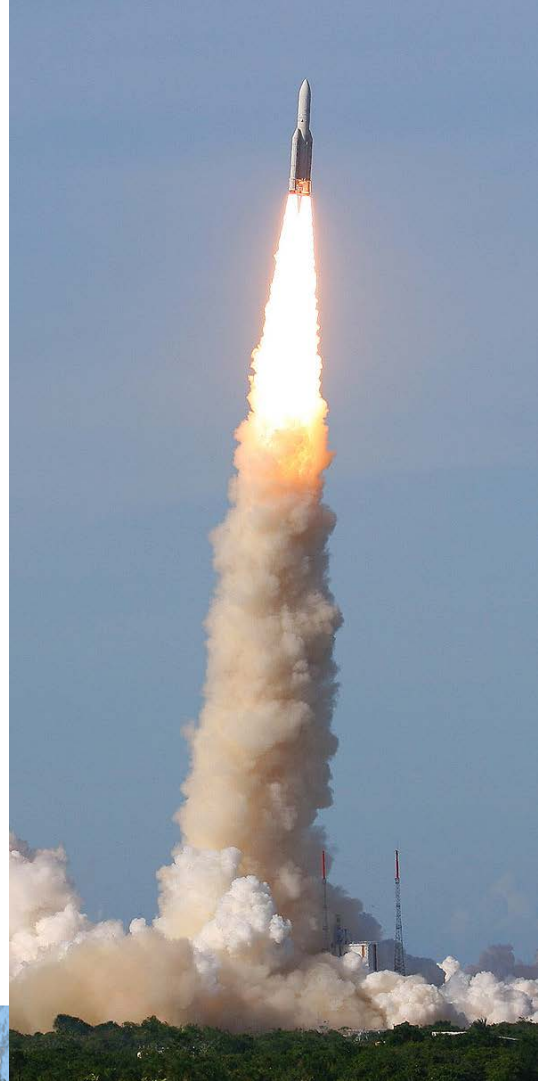
Categories of ATM relevant Space Vehicle Operations (SVO)

Launch Operations
- Expendable Launch Vehicles („classic“ rockets)
- Reusable Launch Vehicles (at least in parts)
    - Reusable / returning first stages / boosters
    - Horizontal launch (with carrier airplane)
    - …

Reentry Operations
- Capsule (Vertical Landing)
- Space Plane, e.g. Shuttle/Lifting Bodies (Horizontal Landing)

Suborbital Research/Tourism flight with „reentry“ vehicle

Suborbital point-to-point travel („SpaceLiner“) concept



Trends in Space Vehicle Operations

Commercialization of Space Transportation:

- Increasing number and types of Space Vehicles
  (operating / under development / suggested)
- Increasing number and variation of mission profiles
  (commercial / governmental / military / touristic)
  (longterm/shortterm/suborbital/point-to-point)
- Space Tourism as viable Business
  (suborbital flight profiles, winged vehicles/horizontal landing)
- Several new Spaceports / new Launch- & Landing sites
  (established / under construction / planned)


[1]


[2]


[3]


[4]

[1] SNC, Mediadata
[2] XCOR, Mediadata
[3] EADS Astrium, Mediadata
[4] Scaled Composites, Mediadata

Suborbital Point-to-Point Travel

General idea

- Hypersonic intercontinental transportation
- Europe to Australia in 90 min.
- Suborbital trajectories
- Several concepts under development

DLR SpaceLiner Concept

- 2 Staged Vertical Launch
- Reusable unmanned Booster returning horizontaly to launch site
- Max. Alt. 80km, Max. Speed Mach20
- Horizontal landing of Orbiter
- Allows 50 – 100 Passengers


DLR SART SpaceLiner 7

SpaceLiner example trajectory [5]

[5] T. Schwanekamp et.al.; Preliminary Multidisciplinary Design Studies on an Upgraded 100 Passenger SpaceLiner Derivative; 18th AIAA/3AF International Space Planes and Hypersonic Systems and Technologies Conference. 2012

Requirements for Air Traffic Management regarding SVO

1) **Ensure the safety of airtraffic- and spaceflight operations**
   Maintain separation between aircraft and space vehicles at all times

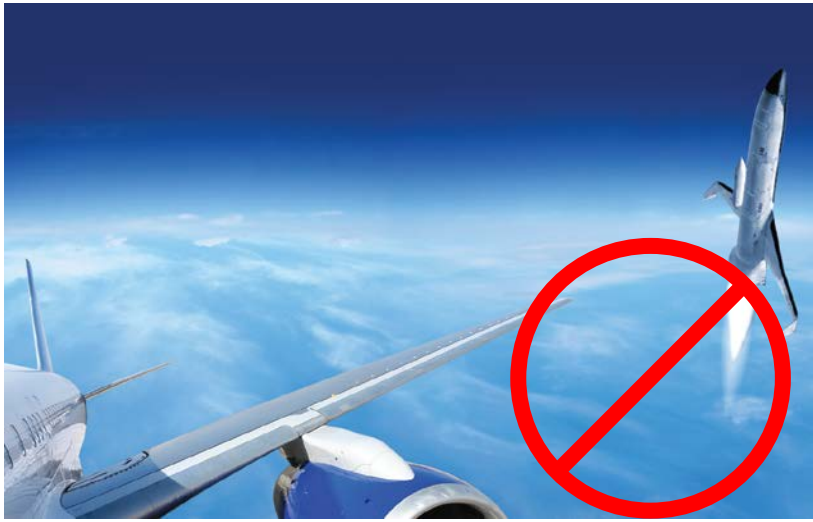
2) **Integrate both kind of operations**

   considering

   → increased number and variation of operations (space vehicle movements)

   → increased number and distribution of space ports

   → increased interaction between SVO and air traffic



→ **increased need for a seamless and efficient integration**

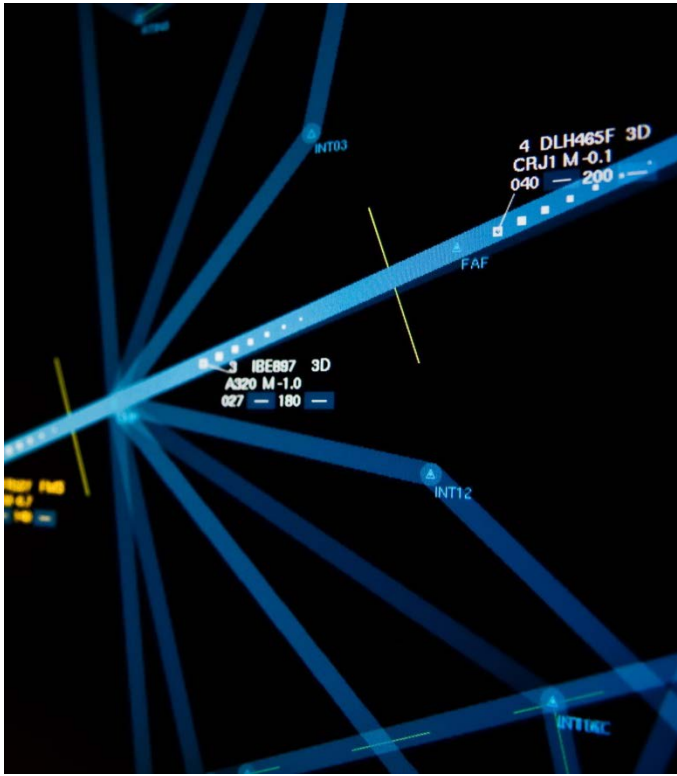
Differences in handling aircraft vs. spacecraft in ATM

Space Vehicles

- do not file a flight plan
- trajectories are predictable but far away from 4D-contracts
- provide limited capabilities to avoid other traffic
  → therefore have to be prioritized
  → therefore need restricted airspace
- often have to delay launch / landing operations

are not (yet) fully integrated into ATS !

are (still) an exception from normal operation !



Limiting the Impact of Spaceflights on ATM

Location of Launch & Landing sites

Selection criteria

- Geographical and weather requirements
- Airspace structure and usage
- Spaceport infrastructure
- Ecological and economical requirements
- Regulatory Framework

Limiting the Impact of Spaceflights on ATM

Current operational practice, as far as applicable, e.g.

- Launch & reentry operation window as short as possible
- Avoid peak traffic times
- Optimize launch & reentry trajectories as far as possible
- Optimize air space usage alongside restricted areas
- Ensure real time monitoring and direct communication, connecting all involved stakeholders with ANSP managers and ATC facilities

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Procedures for Separation Assurance

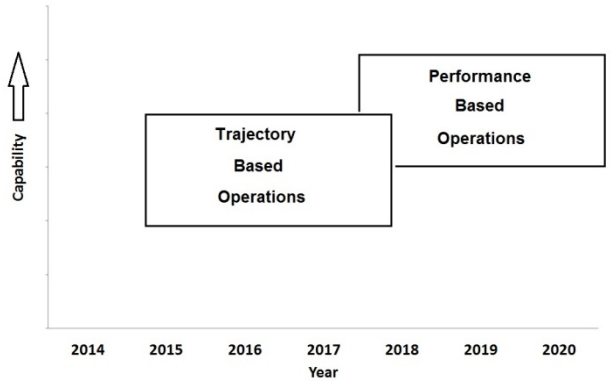
State of the Art (→ FAAs airspace management around space operation [6])

Segregation of airspace around launch and reentry operation

- Joint planning of SVO (Operator + ANSP)
- Calculation of hazard areas, implemented for duration of risk (airspace restrictions)
- Advanced stakeholder and airspace user notification (dedicated issuing of NOTAM)
- Monitoring of operation, distribution of tactical information to ATC for initiation, adaptation and removal of airspace restrictions
- Tactical control of aircraft by ATC to clear hazarded airspace if necessary

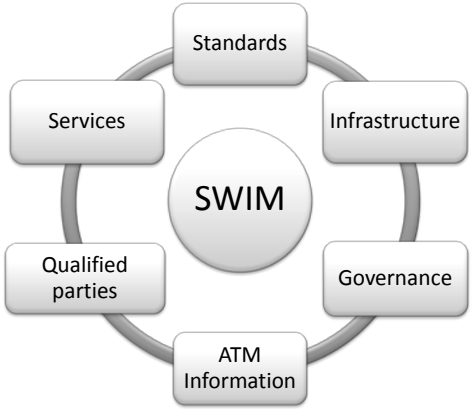
[6] Murray, D.; The FAA‘s current Approach to Integrating Commercial Space Operations into the National Airspace System, May 2013

The European Perspective: SESAR Requirements



Single European Sky ATM Research Programme SESAR

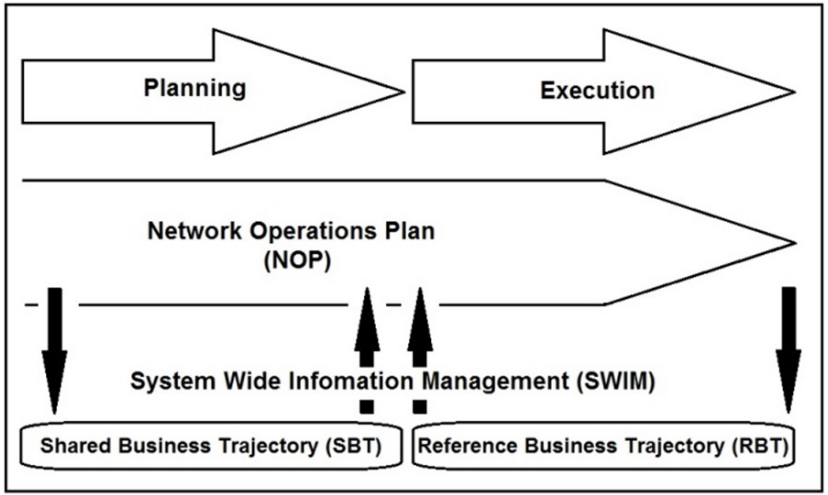
- Business trajectory → Performance based trajectory
- System Wide Information Management SWIM
  - Integration also Controller-Pilot Data Link Communication (CPDLC)
  - Pilots, Airport Operations Centers, Airline Operations Centers, Air Navigation Service Providers, Meteorology Service Providers, Military Operations Centers



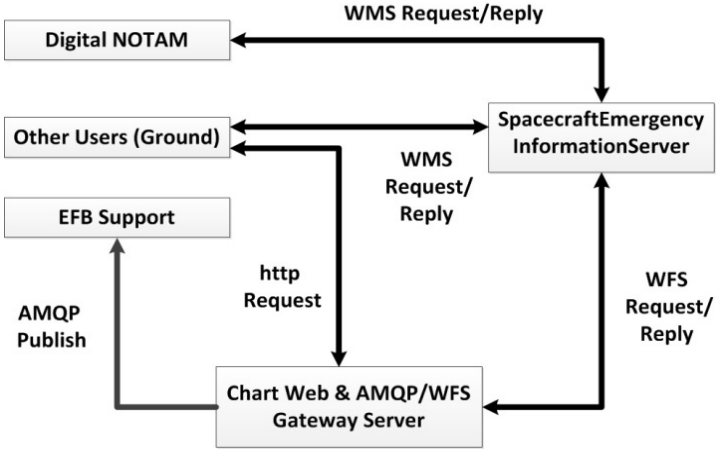
SWIM in SESAR

From Planning to Sharing to Execution

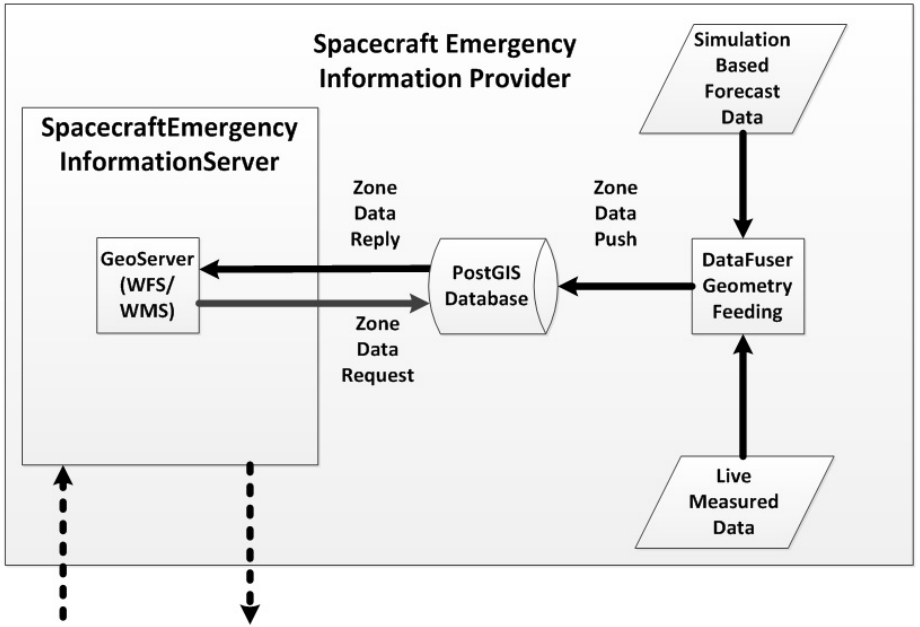
- Business Development Trajectory BDT
- Shared Business Trajectory SBT
- Reference Business Trajectory RBT



Integrating SVO into SESAR via SWIM, e.g. SpaceCraftEmergencyInformationServer



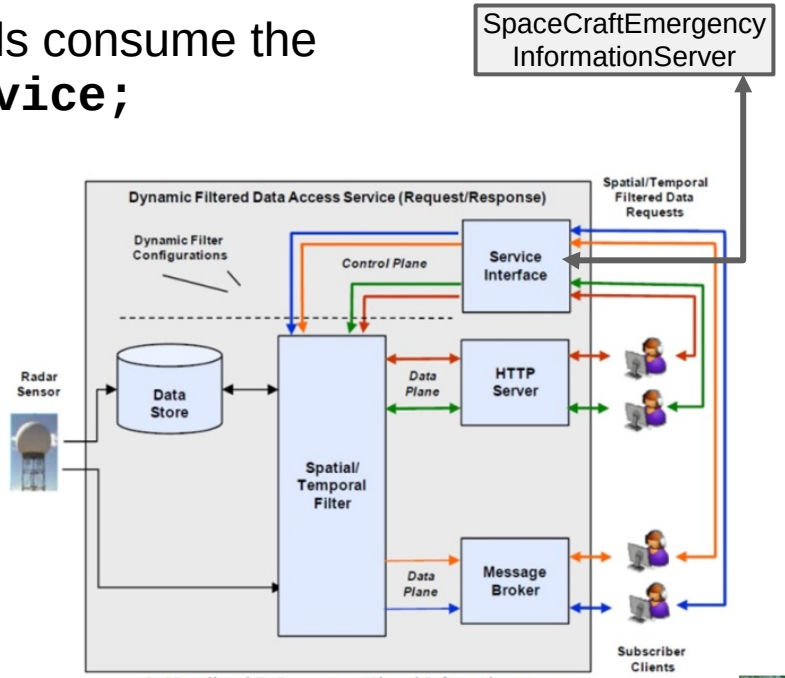
General approach



SEIS Data Fusing Application

Suggested Spacecraft Flight Planning and Execution

1. Checking potential hazard areas by making the IFPS Validation System a **`SpaceCraftEmergencyInformationService`** consumer
2. Air traffic controller surveillance assistant tools consume the **`SpaceCraftEmergencyInformationService;`** ATC issuing associated voice commands to other aircraft
3. Standard http requests for pre-formatted web charts to a chart web server
4. EFB software as an AMQP subscriber to the gate way server AMQP

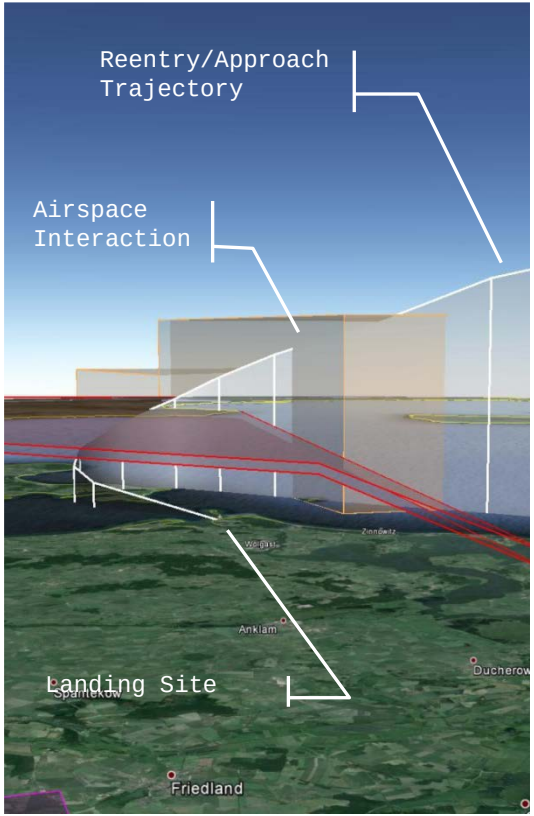


O. Newell and B. Levasseur, "Shared Information Access Services in SWIM Segment 2: An Architectural Overview," Project Report ATC-383, Lincoln Laboratory MIT, 31 October 2012

DLR research on integrating Spaceflight into ATM

Seamless and efficient integration of airtraffic- and spaceflight operations

- Analysis and optimization of SVO scenarios and concepts regarding air traffic impacts
- Improved ATC procedure design
- Support of Spaceport site evaluation
- Integration of SVO Mission management and ATM
- Improved SVO implementation into AIM (e.g. SWIM)
- Provision of adequate evaluation and validation capabilities



Summary

- Increased need for efficient airtraffic and spaceflight integration
- Dedicated SVO-SWIM services will facilitate seamless operations
- DLR is commited to support the integration of spaceflight into ATM


Thank you very much for your attention !
DLR