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

ICAO / UNOOSA Aerospace Symposium
18–20 March 2015,
ICAO Headquarters,
Montréal, Canada
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 Air Traffic Validation Center

Model-based Tools
- TrafficSim
- SIMMOD
- Pre-/Post-Processing
- AirTop
- Smallscale Simulation

Real-Time (HIL) Simulators
- Tower-Simulator
- ATC-Simulator
- Ext. Simulators
- Ext. Towers

External Testbeds
- ARIF Hamburg
- Ext. Aircraft
- Ext. Airports
- Ext. ATC Centers
- Ext. Towers

Airport Research Facility
- Datalink
- RTO-Cameras
- MLAT / WAM
- GBAS
- DLR Research Aircraft
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] 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 horizontally to launch site
- Max. Alt. 80km, Max. Speed Mach20
- Horizontal landing of Orbiter
- Allows 50 – 100 Passengers

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 (→ FAA's 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

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 gateway server AMQP
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 committed to support the integration of spaceflight into ATM
Thank you very much for your attention!