

COE CST Eleventh Annual Technical Meeting

Interoperable Air and Space Traffic Management

Sven Kaltenhaeuser



Center of Excellence for
Commercial Space Transportation



Agenda

- Team Members
- Task Description
- Goals
- Results
- Conclusions and Future Work

Team Members



Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

- Principal Investigator: Sven Kaltenhaeuser
- Core-Team: Dr. Dirk-Roger Schmitt, Carmo Klünker
- Student: Jolin Neuss



- Organization
 - **DLR German Aerospace Center**
Institute of Flight Guidance
Associate Member of the COE CST

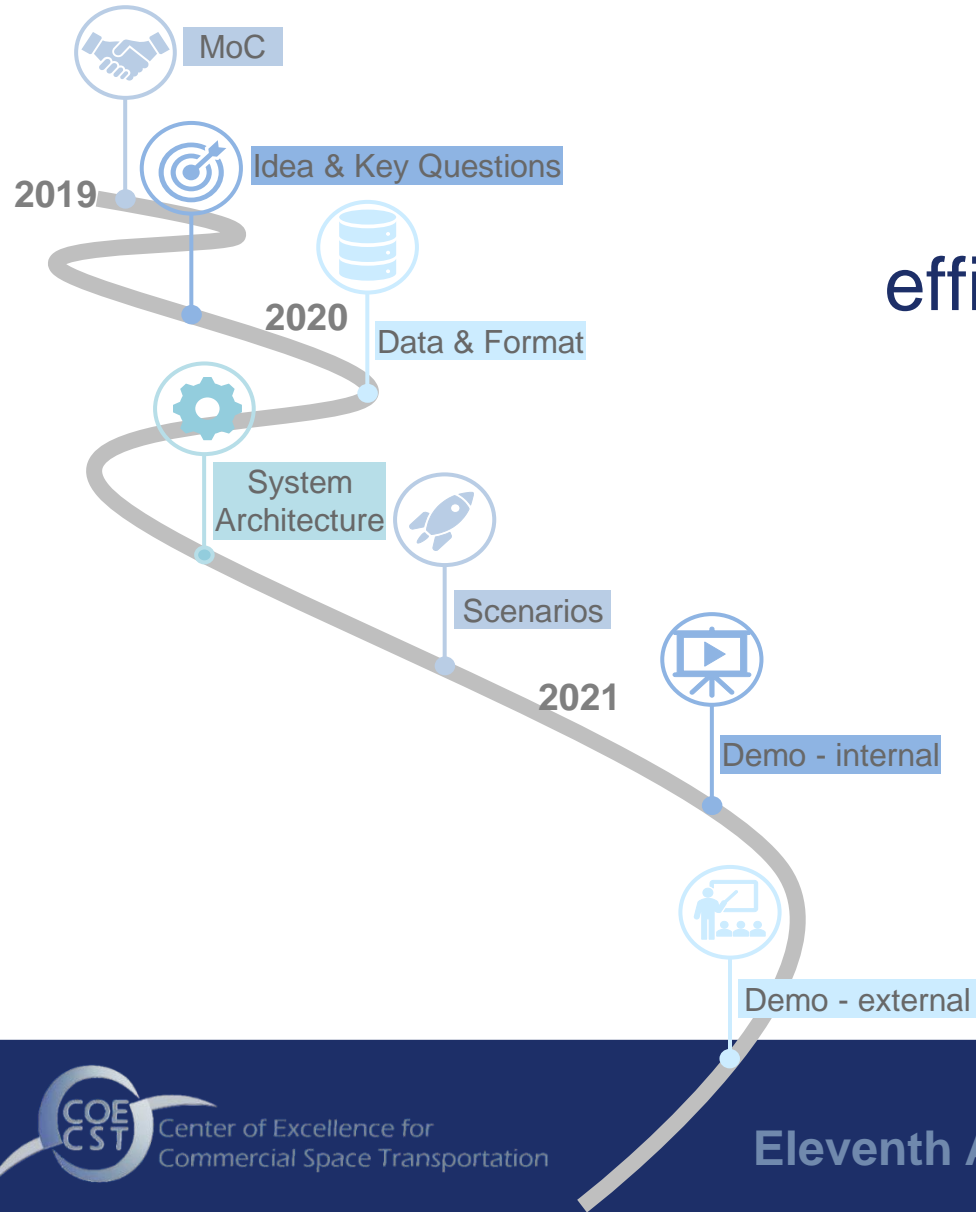
Task Description

- With global growth of the commercial space industry there is a developing demand for space flight operations in and over Europe. Air Traffic Management (ATM) is playing a key role to address this challenge.
- The goal is to prepare the European ATM system to enable a safe integration of space vehicle operations (SVO) in a sustainable and efficient way. To enable global operations, interoperability of implemented technologies and procedures is an essential requirement and a specific focus of the DLR work program.

Goals

1. Categorization of relevant space flight operations and assessing their impact on European airspace using the DLR Space and Air Traffic Management (SATM) testbed.
2. Development of measures and procedures for enabling efficient ways to optimize airspace usage for space flight operations while minimizing airspace segregation.
3. Development of concepts and prototypes for a seamless, safe and secure implementation of space flight operations into the ATM using System Wide Information Management (SWIM) and related open and standard mainstream technologies.

Results



DLR FAA Data Exchange Project

Interoperable data exchange for safe and efficient launch and reentry (L/R) operations

DLR-FL: Sven Kaltenhäuser, Carmo Klünker et al.
FAA-AST: Dan Murray, Magda Batista-Carver, et al.

Memorandum of Cooperation (MoC) in the **development of commercial space transportation** signed October 24, 2019 by the **DLR** and the **FAA Office of Commercial Space Transportation (FAA AST)**.



Results

DLR FAA DEP – Concept



Demonstrating a way of integrating STM into ATM by exploring space data exchange on an international level between **operators** and air navigation service providers (**ANSPs**) to **increase situational awareness** and the ability to **respond to non-nominal events** during space operations thus **improving efficiency and safety.**



Results

DLR FAA DEP – Key Questions

1

What data should be exchanged for commercial space L/R operations?

2

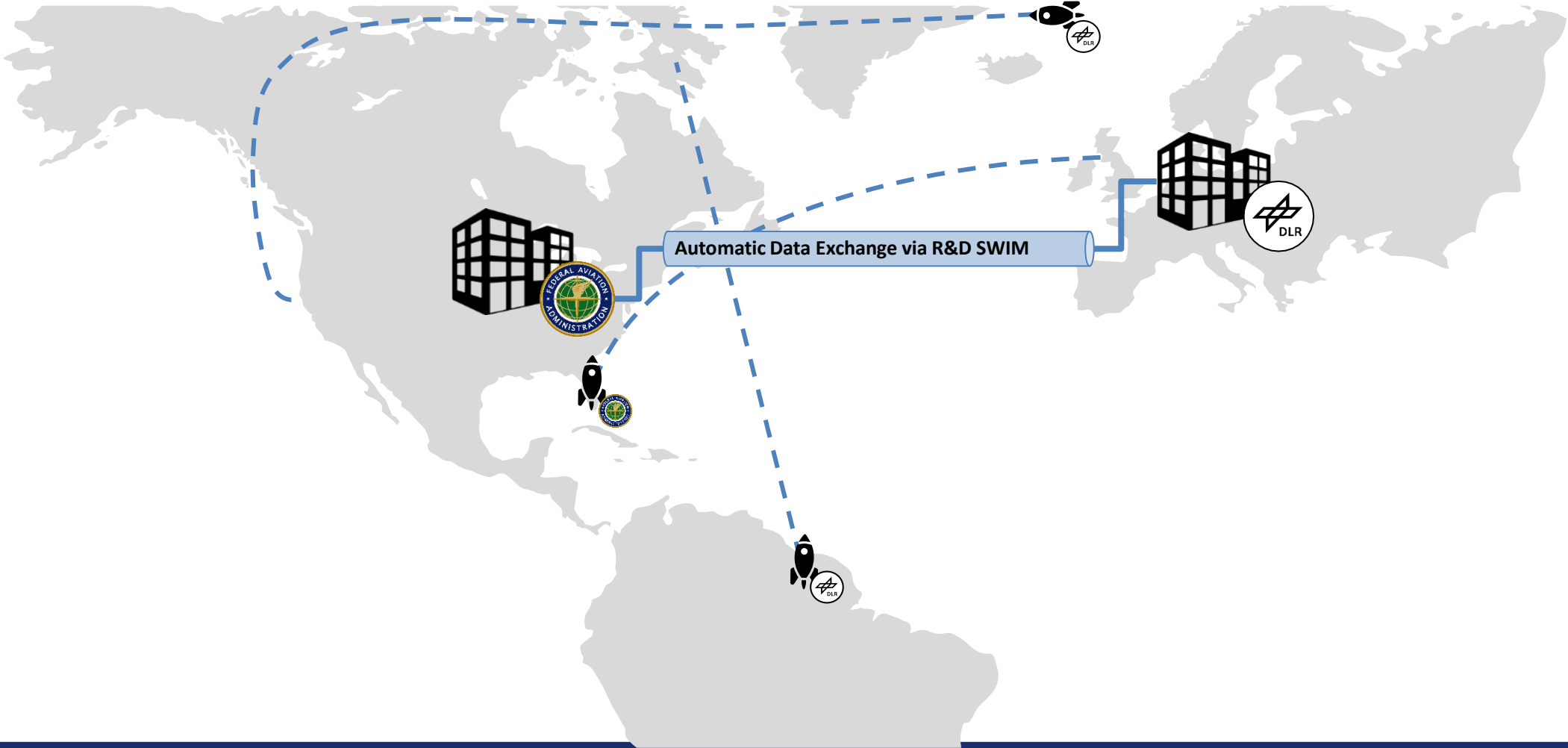
In what timeframe (prior, during & after commercial space L/R operations) does the data need to be exchanged?

3

What is the utility of the data exchanged?

Results

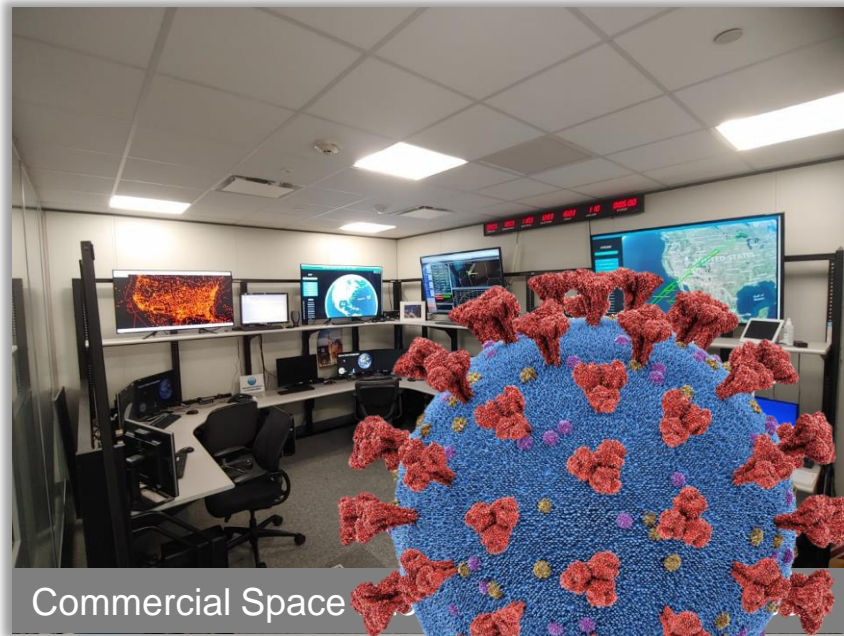
DLR FAA DEP – Simulation Scenarios



Results

DLR FAA DEP – Internal Demo

International cross-border automatic data exchange during simulated launch missions performed from ...

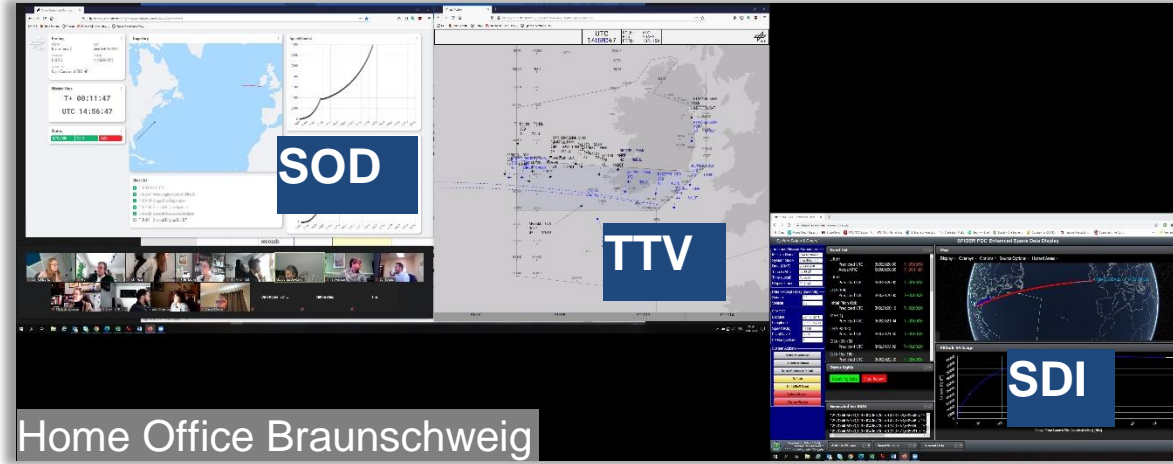
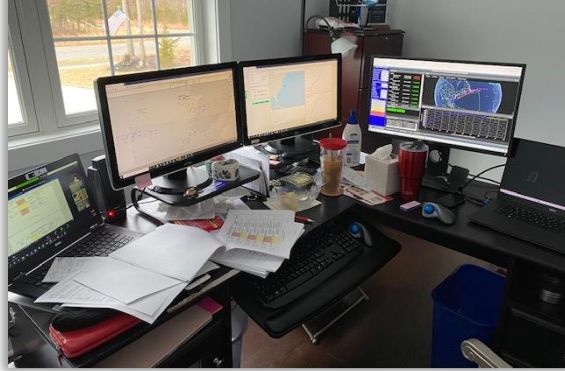


Results

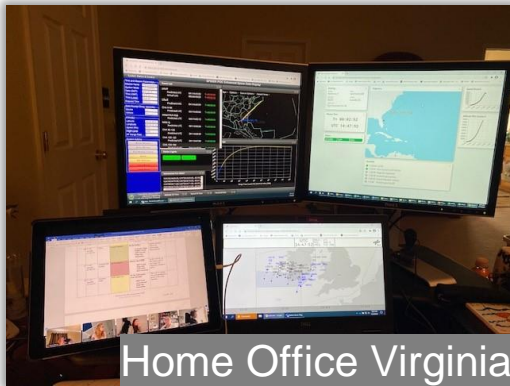
DLR FAA DEP – Internal Demo

International cross-border data exchange during simulated launch missions performed from ...

Home Office New Jersey



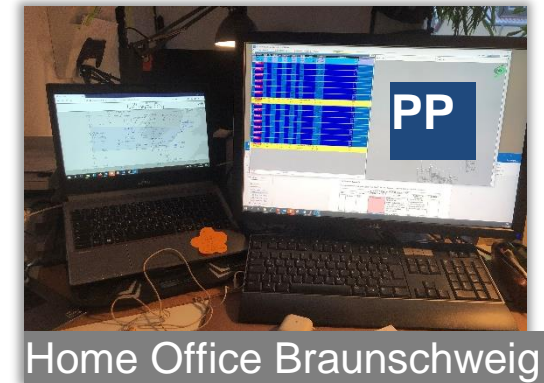
Home Office Braunschweig



Home Office Virginia



Home Office Braunschweig

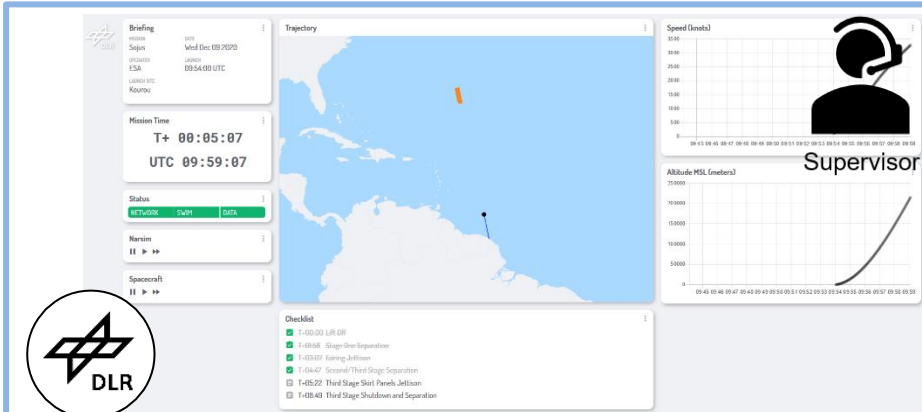


Home Office Braunschweig

*SOD = Space Operations Dashboard, SDI = Space Data Integrator, TTV = Traffic Trajectory Visualization, PP = PseudoPilot

Results

DLR FAA DEP – Demonstrations: Tools

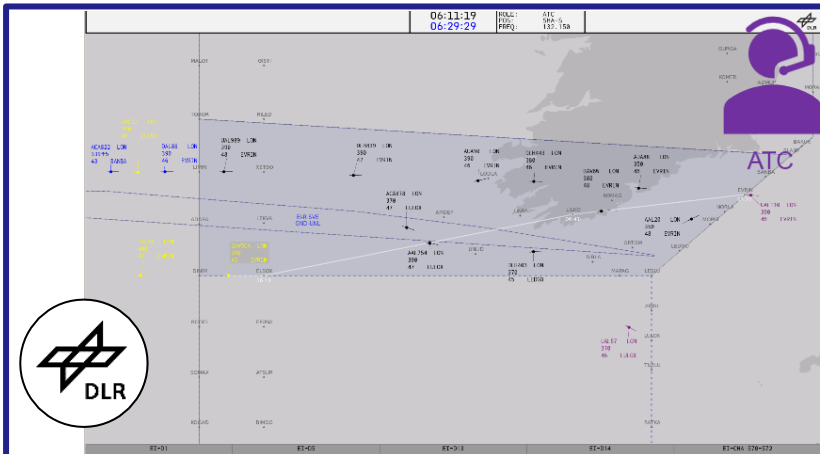


Space Operations Dashboard (SOD)

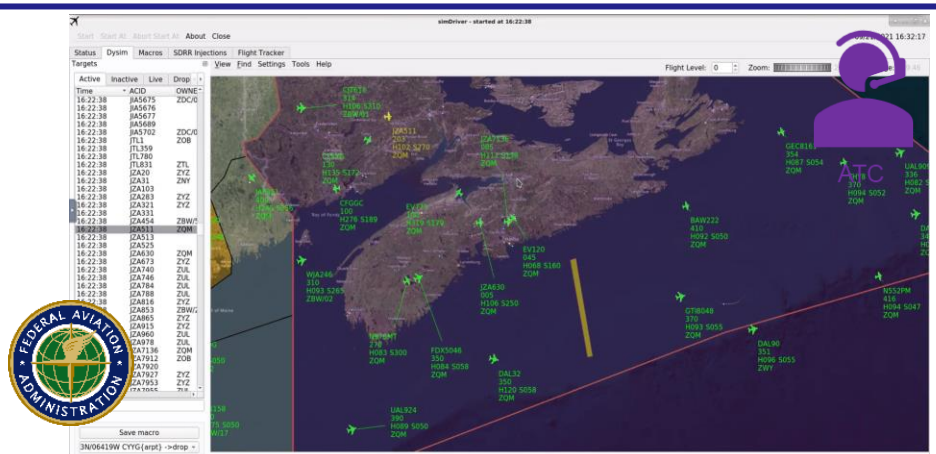


Space Data Integrator (SDI)

Prototypes for mission monitoring



Traffic & Trajectory Visualization (TTV)



SLICK Traffic Simulation

Traffic Visualisation for Utility Assessment

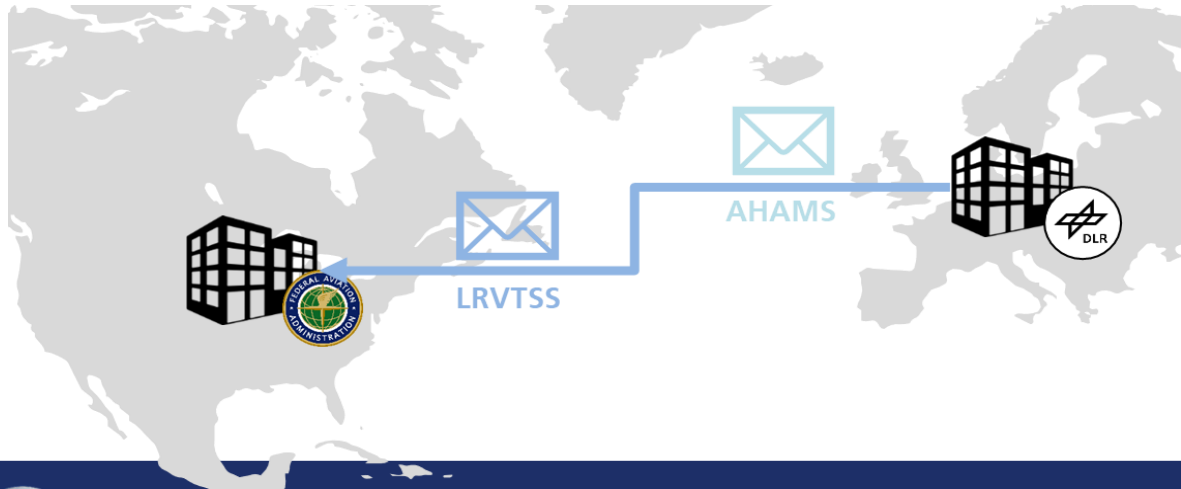
Results

DLR FAA DEP – Demonstrations: Results

Sequence: LOS detected - Analysis of situation / communication via hotline - LRO confirms time of LOS - RHA generated - RHA transmitted - RHA received.

Duration sequence run: **37-62 seconds**

Generation and transmission of the **RHA: 1-2 seconds**



	US-to-EU		
	Loss of Signal (LOS)	On-Trajectory Explosion	Abort
LOS detected	13:54:30	14:54:30	15:19:29
Generate RHA	13:55:23	14:55:31	15:20:05
Receipt of RHA	13:55:25	14:55:32	15:20:06
Time LOS-Receipt	55 s	62 s	37 s

Transmission errors in the FAA R&D SWIM system
→ **Lost messages between Producer & Consumer**

SWIM error handling performed
→ Error located and fixed
→ **Further tests showed correct data processing by SWIM.**

Results

DLR FAA DEP

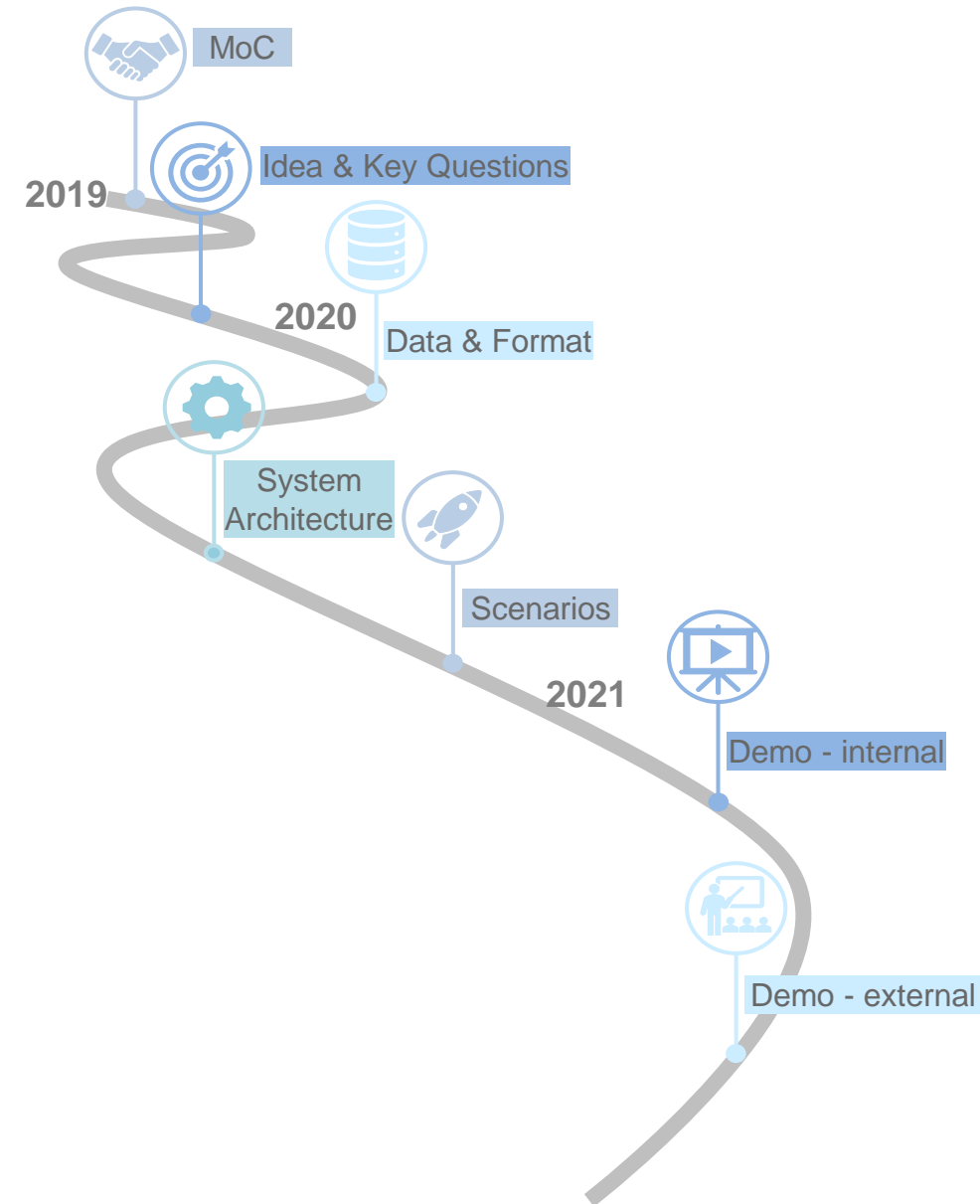
DLR FAA Data Exchange Project

Interoperable data exchange for safe and efficient launch and reentry (L/R) operations



Results in a nutshell

- Commercial Space Data can be exchanged and utilized for L/R and air traffic management.
- The concept is transferrable to other operations (countries).



Publications, Presentations, Awards, & Recognitions

PUBLICATIONS

1. Klünker, Carmo Sonja und Kaltenhäuser, Sven und Schmitt, Dirk-Roger (2021) Grenzüberschreitender Austausch von Raumfahrzeugdaten zur sicheren und effizienten Durchführung von Weltraumaktivitäten. Deutscher Luft- und Raumfahrt Kongress (DLRK), 31. Aug. - 02. Sep. 2021, Bremen.
2. Klünker, Carmo Sonja und Neuß, Jolin (2021) Data Exchange Project (DEP) Eine Kooperation des Deutschen Zentrums für Luft- und Raumfahrt (DLR) und der Federal Aviation Administration (FAA). Deutscher Luft- und Raumfahrt Kongress (DLRK), 31. Aug. - 02. Sep. 2021, Bremen.
3. Kaltenhäuser, Sven und Klünker, Carmo Sonja (2021) Cross-border exchange of spacecraft data for the safe and efficient execution of space activities. FAA Quick Look, 30. November 2021.
4. Kaltenhaeuser, S., Morlang, F., Schmitt, D.-R. (2022 planned) Interoperable data exchange for safe and efficient launch and re-entry operations in an international environment, IAC 2022, Paris

Conclusions and Future Work

DLR FAA DEP Follow-up

- Integrate the data exchange concept into ATM and ATC processes and procedures, for national and international operations.
- Internationally harmonized/standardized methods for risk assessment and calculation of hazard areas.
- International agreements on how the demonstrated concept, including the pipeline, can be applied to real operations.

Up next @DLR: Project Spacetracks

- DLR is building a demonstrator of a Launch Coordination Center at its Braunschweig site.
- Objective: Coordinate launches and re-entries safely with air transport and maritime navigation activities.
- The aim is the subsequent transfer of the technology to routine operations.

https://www.dlr.de/content/en/articles/news/2021/03/20210923_dlr-is-developing-a-launch-coordination-center.html