Session II: Technical Details and Demonstration Results

Technical development: Overview and approach
Prajwal Shiva Prakasha (DLR) and Thierry Lefebvre (ONERA)

Framework: Development & implementation of a collaborative framework for aviation impact assessment
Marko Alder et al. (DLR)

Use Case 1: Assessing advanced propulsion systems using the Impact Monitor Framework
Atif Riaz et al. (CU)

Use Case 2: Assessing continuous descent operations using the Impact Monitor Framework
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Use Case 3: Assessing policies for the uptake of sustainable aviation fuels using the Impact Monitor Framework
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IMPACT MONITOR

Framework

Development and implementation of a collaborative framework for aviation impact assessment

DLR

Cranfield University

ONERA
THE FRENCH AEROSPACE LAB

Marko Alder, Patrick Ratei, Prajwal Shiva Prakasha, Atif Riaz, Thierry Lefebvre

14th EASN International Conference | Thessaloniki | 9th October 2024

Funded by the European Union under GA No. 101097011. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or CINEA. Neither the European Union nor CINEA can be held responsible for them.

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Coordinated by the German Aerospace Center

Introduction: Aviation as a System of Systems

- **Challenge**
  Efficient interaction between experts is essential to assess global impacts like airport procedures, fleet strategies, and policy impacts.

- **Goal**
  Development of a collaborative framework to manage this complexity and enable the formulation and execution of impact assessment studies.

Credits: Kaiser, J., Vernaleken, C. (2012). Civil Aviation. In: Stein, M., Sandl, P. (eds) Information Ergonomics. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-25841-1_5

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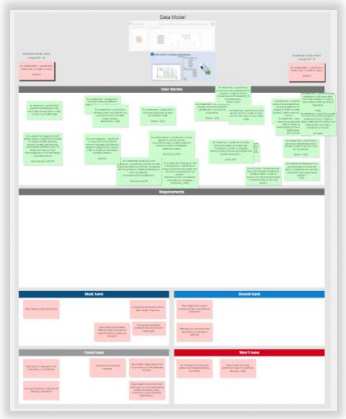
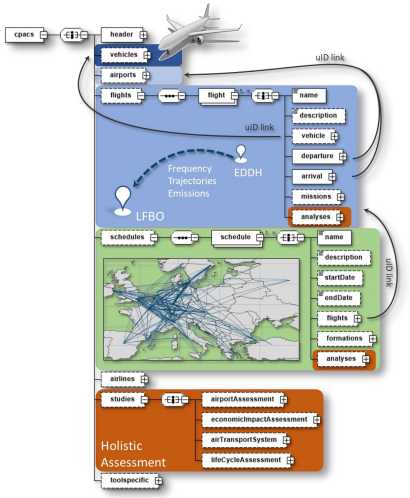
Agenda

Requirements



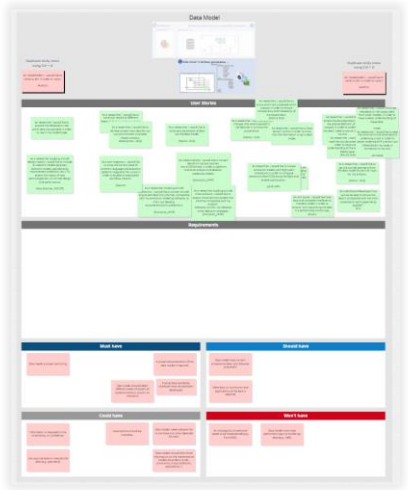
Technologies

Implementation



Requirements: Methodology

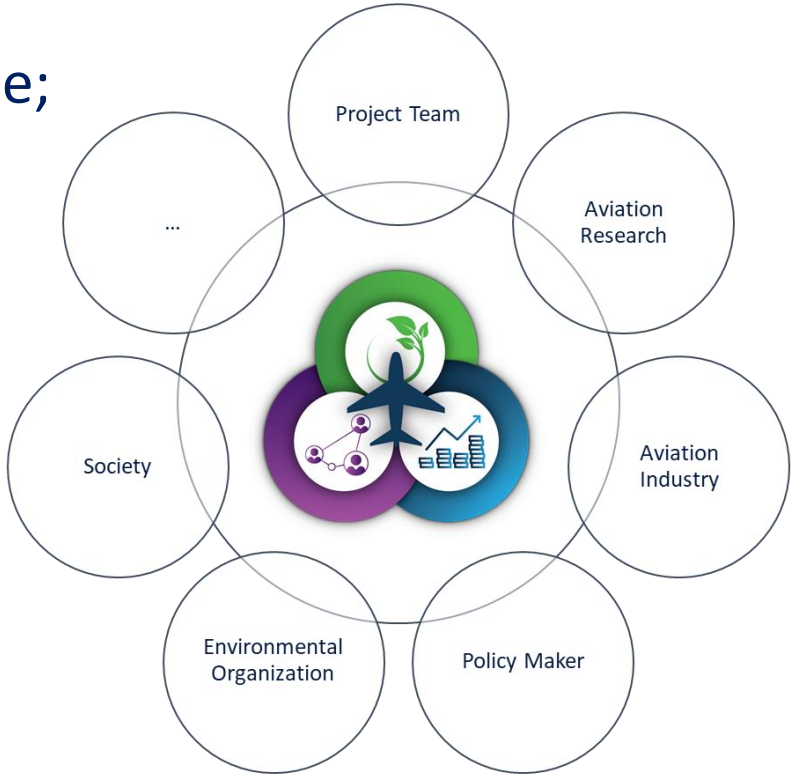
- Interactive online workshop with the project team to
  - Generate as many potential **user stories** as possible;
  - **Group** similar user stories;
  - Derive **requirements** from user stories;
  - **Prioritize** requirements.



data model

framework

visualization



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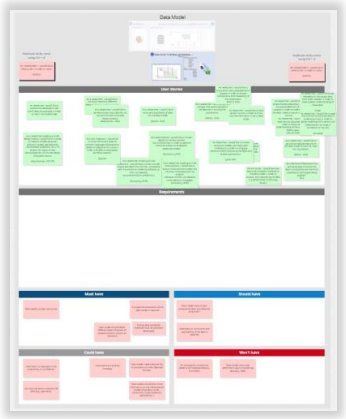
Requirements: Key Considerations

Data Model

- Documentation and versioning
- Multilevel hierarchy
- Provenance data
- Meta data
- …

Agenda

Requirements



Technologies

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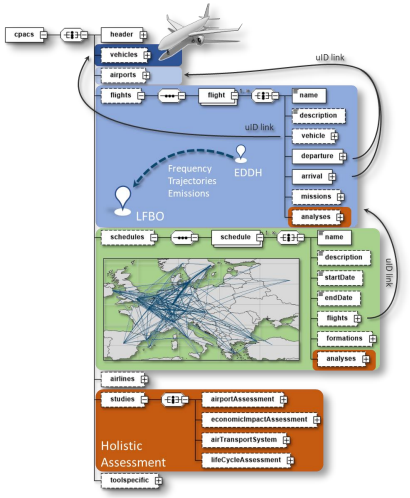
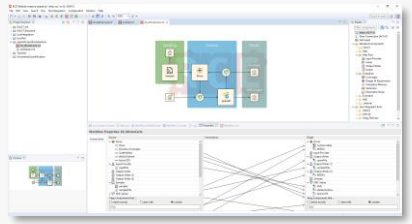


Framework Architecture

II Framework: Data repository, workflow execution, …

Workflow Execution



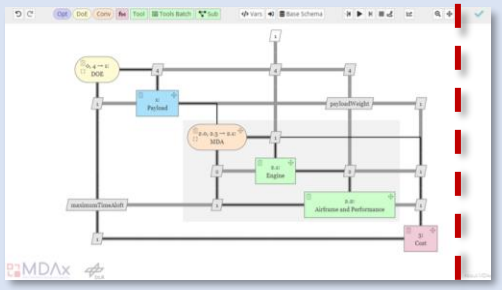
- Secure remote execution

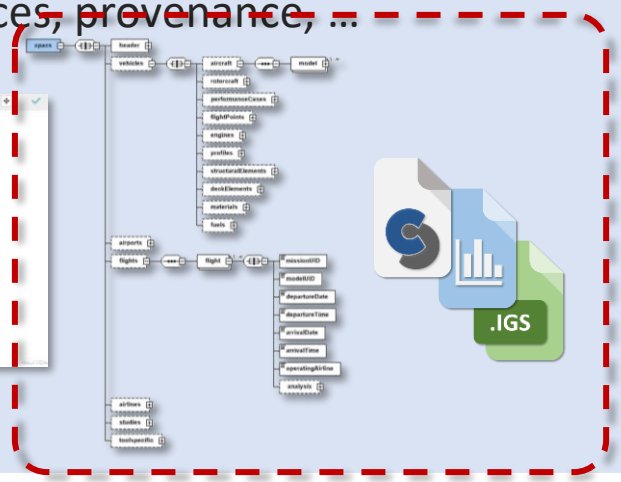
Data Management

- Documentation
- User management
- Server-based result data base

WebDAV

I Data model: Interfaces, provenance, …





III Dashboard

REST API

Back-end

Data processing and surrogate models

1. Accessing and retrieving data from results database
2. Meta models based on existing results
3. …

Front-end

Web-based dashboard application

1. KPIs & metrics from WP5 to derive default plot types
2. Data visualization and analysis based on user needs
3. User authentification form
4. …

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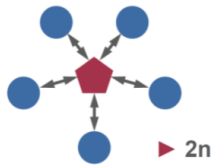
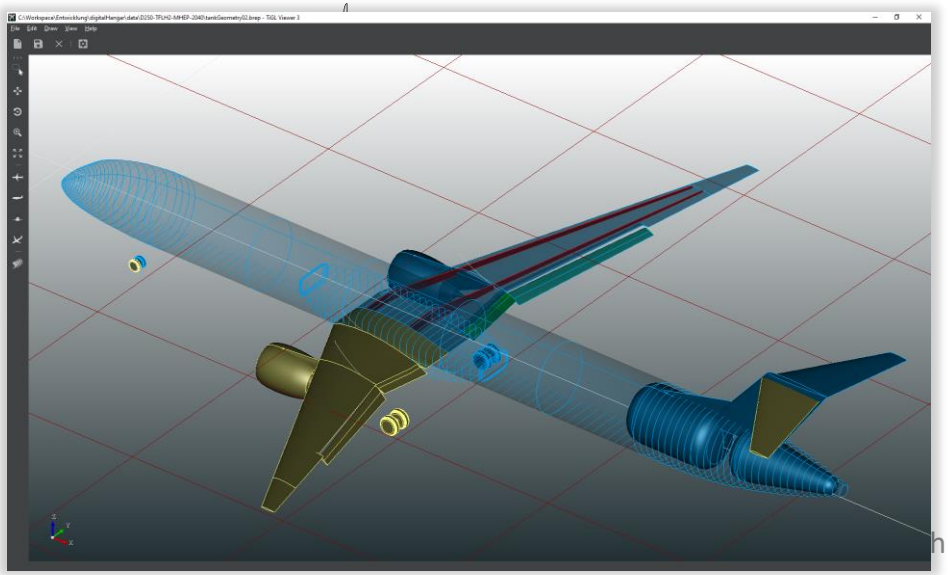
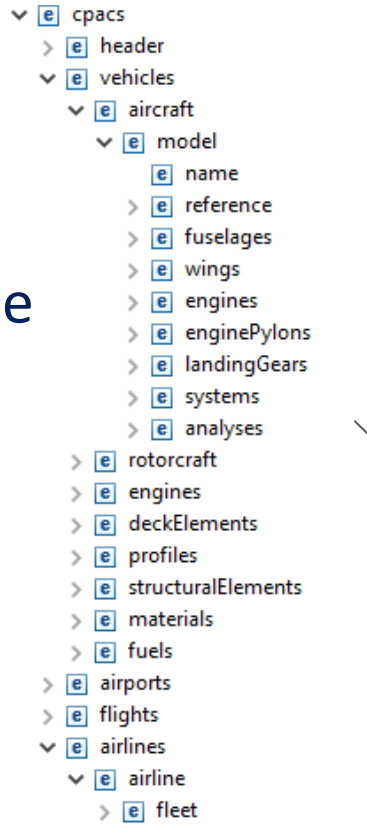
Technology: Data Exchange Model

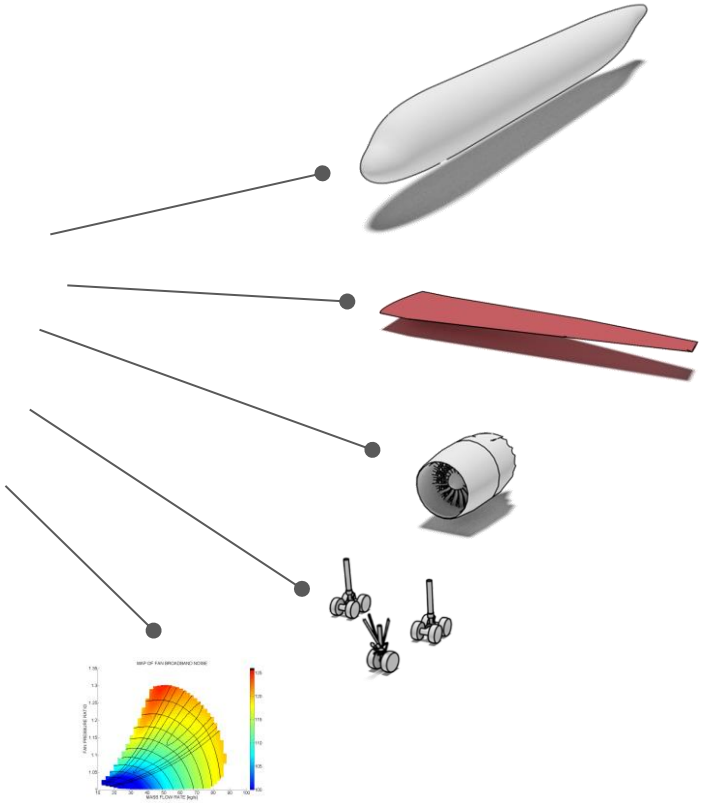
CPACS (Common Parametric Aircraft Configuration Schema)

- Common language for aircraft design
- Exchange of specialist knowledge
- Developed since 2004, based on XML / XSD
- Human readable – Standardized – Open-Source









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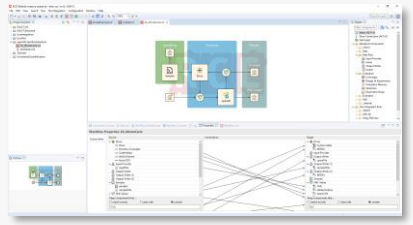

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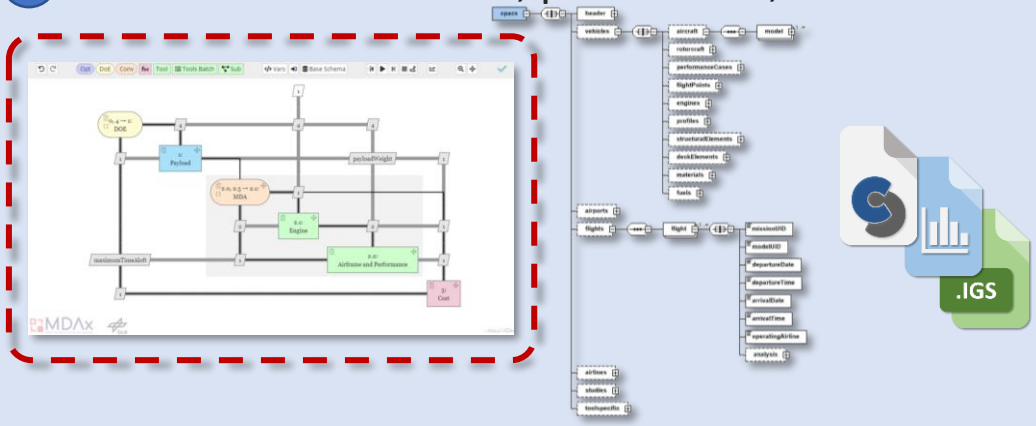

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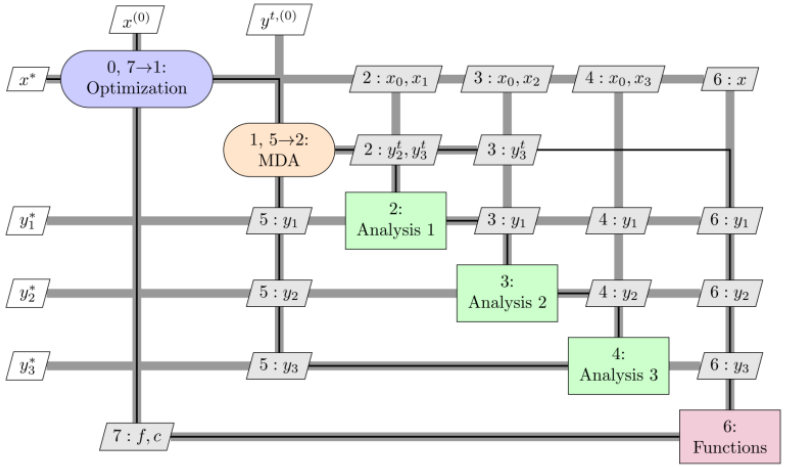
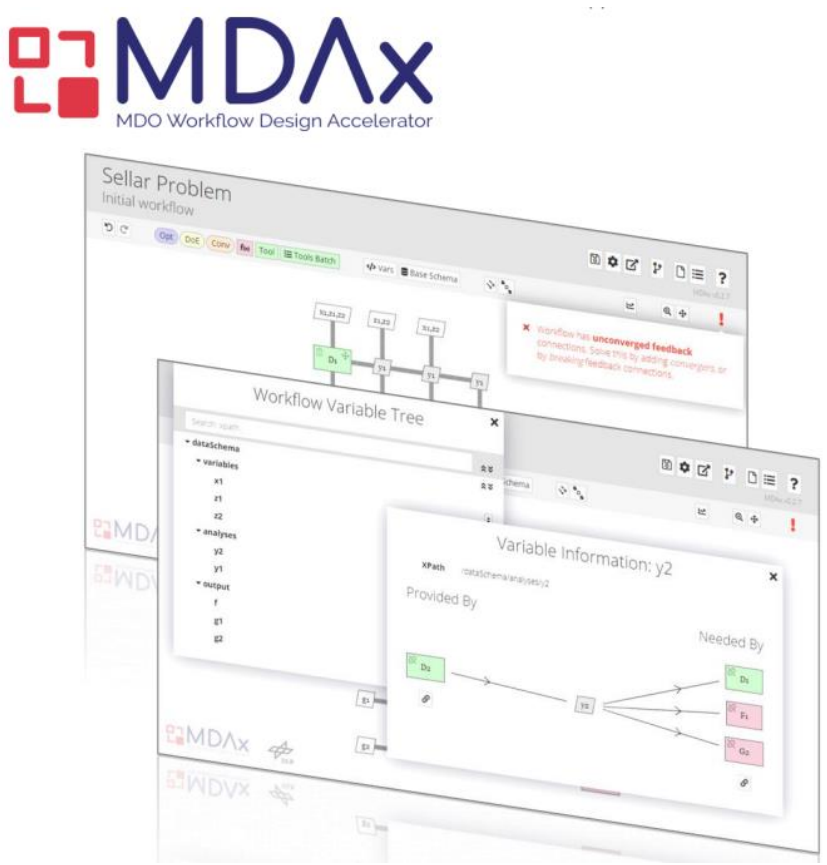
Technology: Digital Workflow Model

MDAx (MDO Workflow Design Accelerator)

- Developed by DLR, open-access (light)
- Model interface coupling
- Modelling and inspection of workflows





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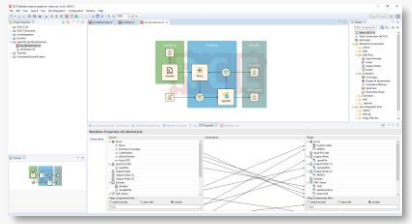

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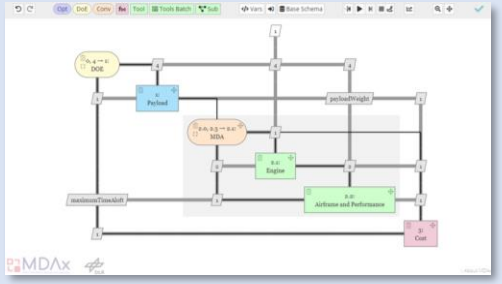

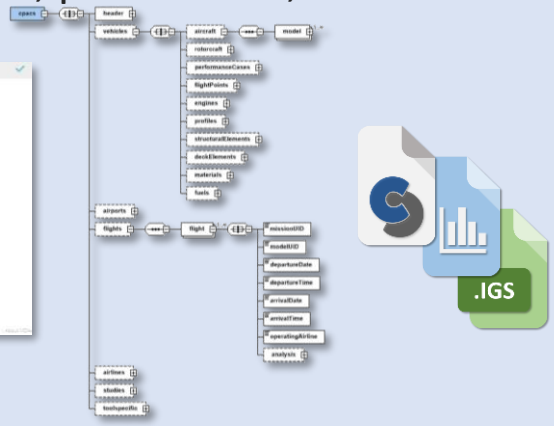

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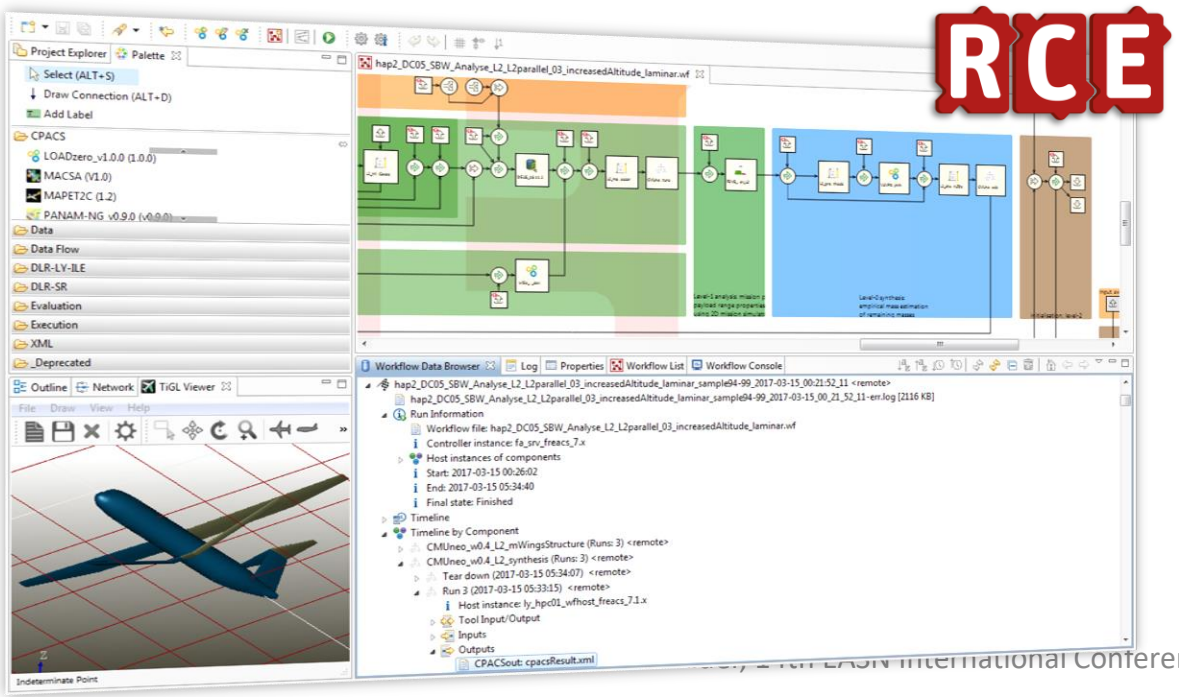
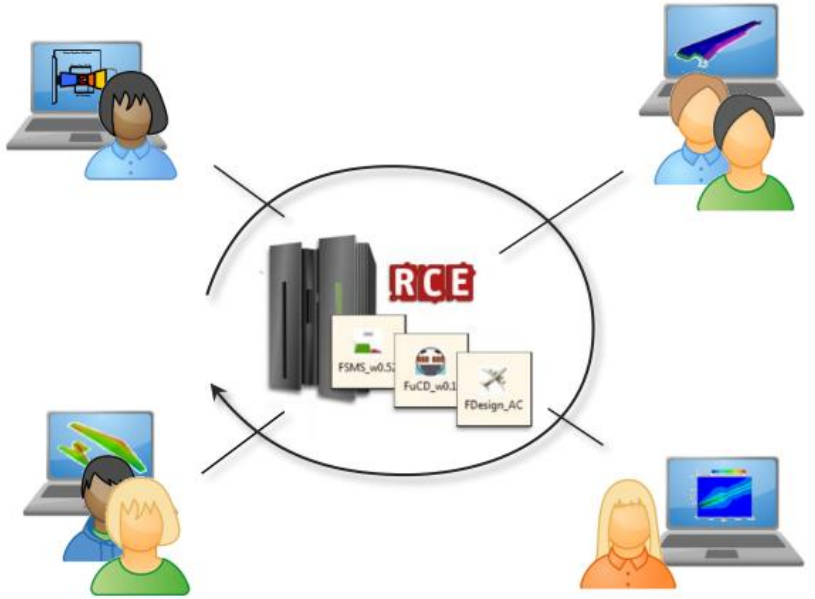
Technology: Remote Workflow Execution

RCE (Remote Component Environment)

- Developed by DLR, open-source software
- Enabling automated, collaborative workflows across organizations and allowing large number of studies without sharing proprietary software code





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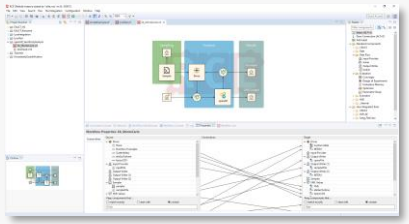

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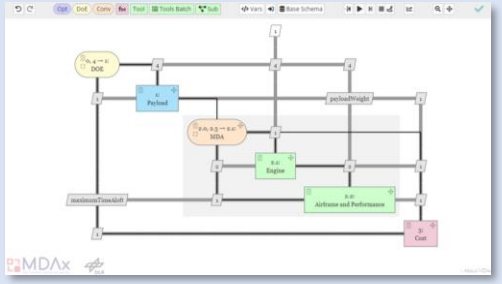

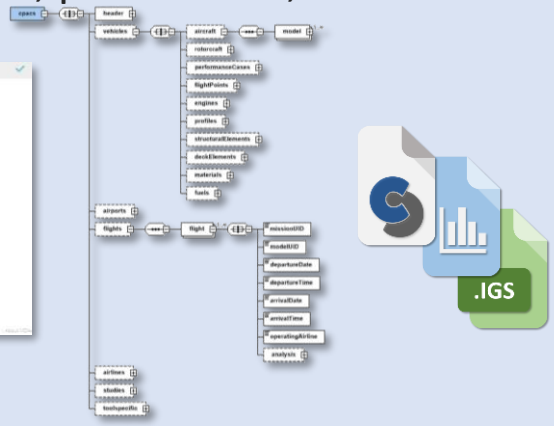

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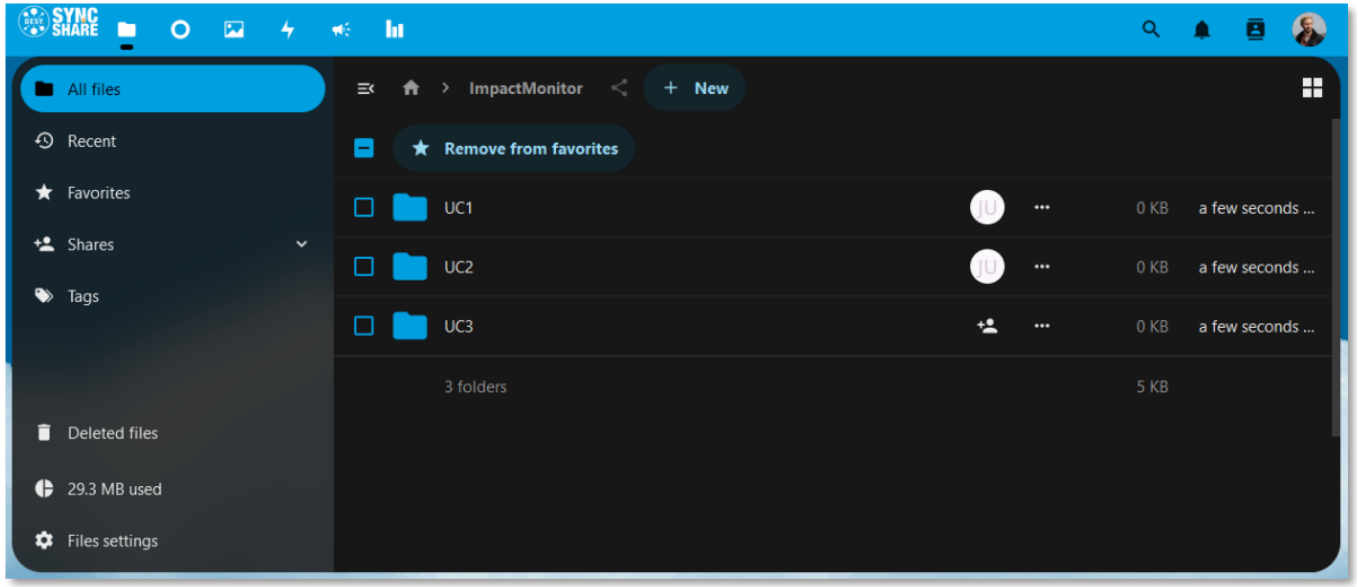
Technology: Data Repository

NextCloud

- Prototype instance hosted by Helmholtz (incl. authentication)
- Accessible via web browser (UI) and software components (WebDAV API)



Framework Architecture

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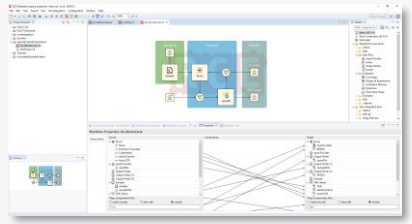

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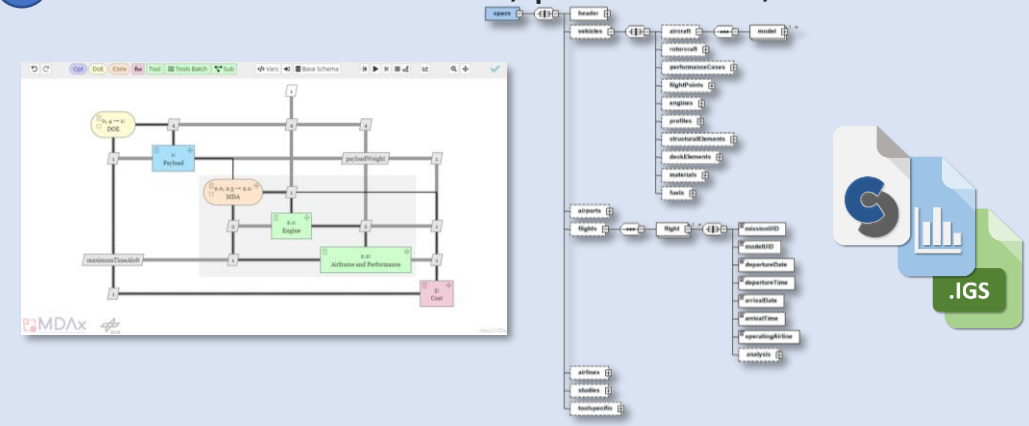

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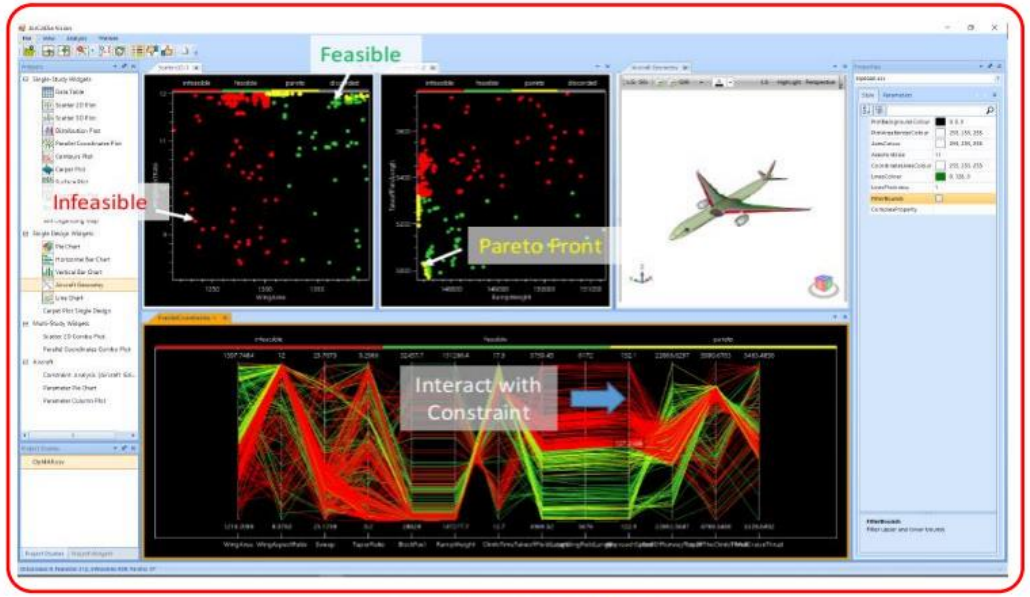
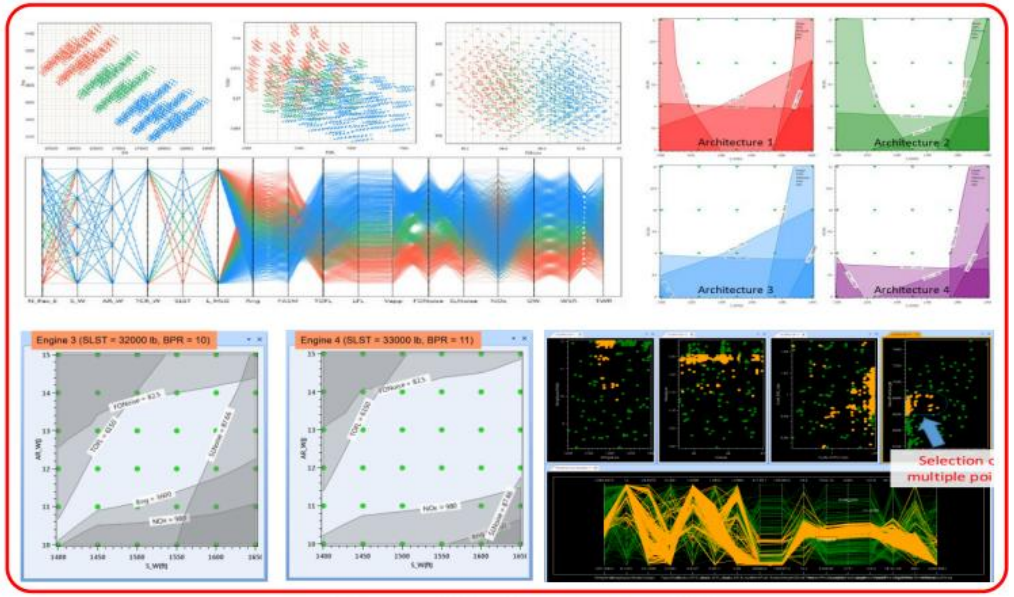
Technology: Dashboard Application

AirCADia

- Developed by CU, closed software
- Interactive design space exploration through data/visual analytics



Screen Capture of AirCADia Vision



Different Widgets for Visual Analytics

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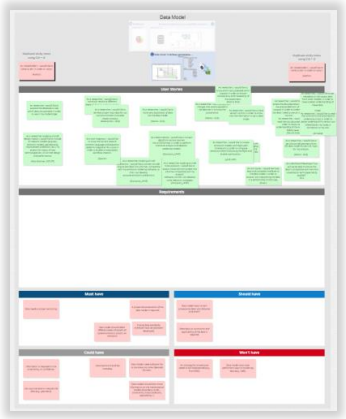
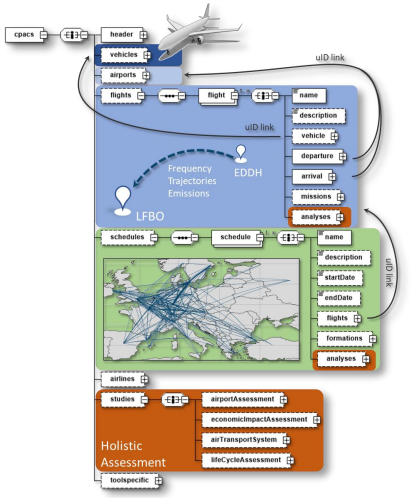
Agenda

Requirements



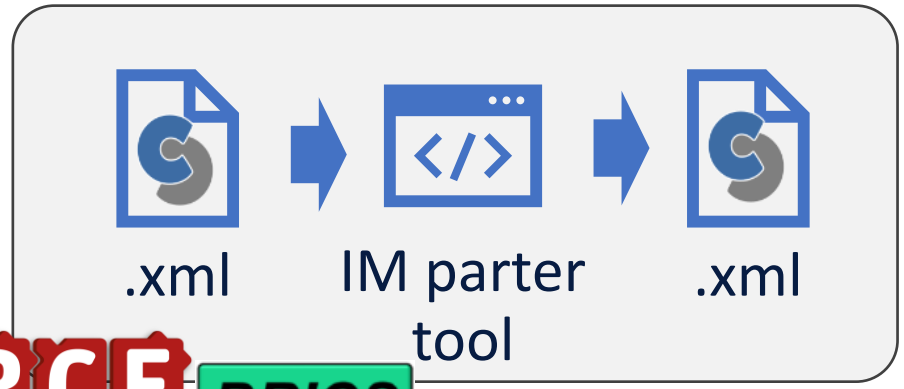
Technologies

Implementation



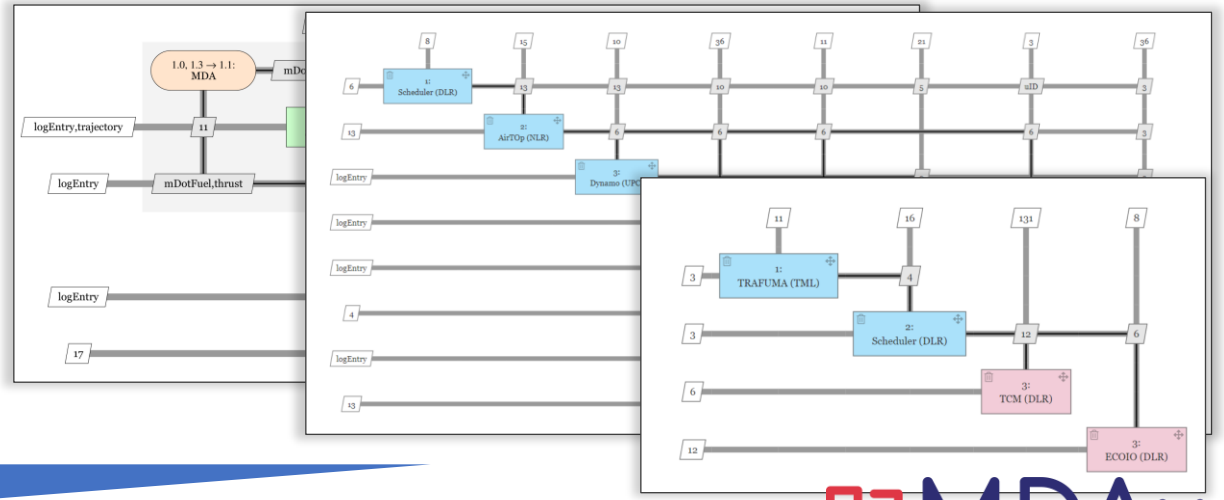
Implementation

Connection of tools to CPACS & RCE



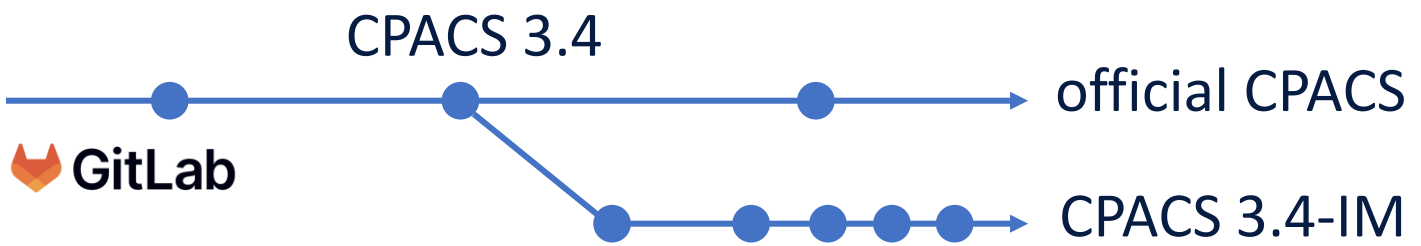
RCE BRICS

Identification of data to be exchanged

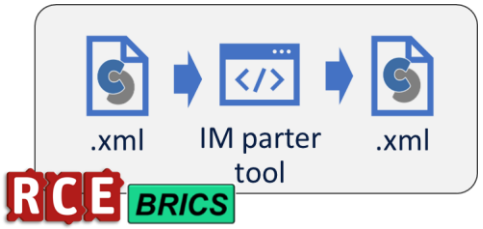


MDAx
MDO Workflow Design Accelerator

Modification & extension of CPACS

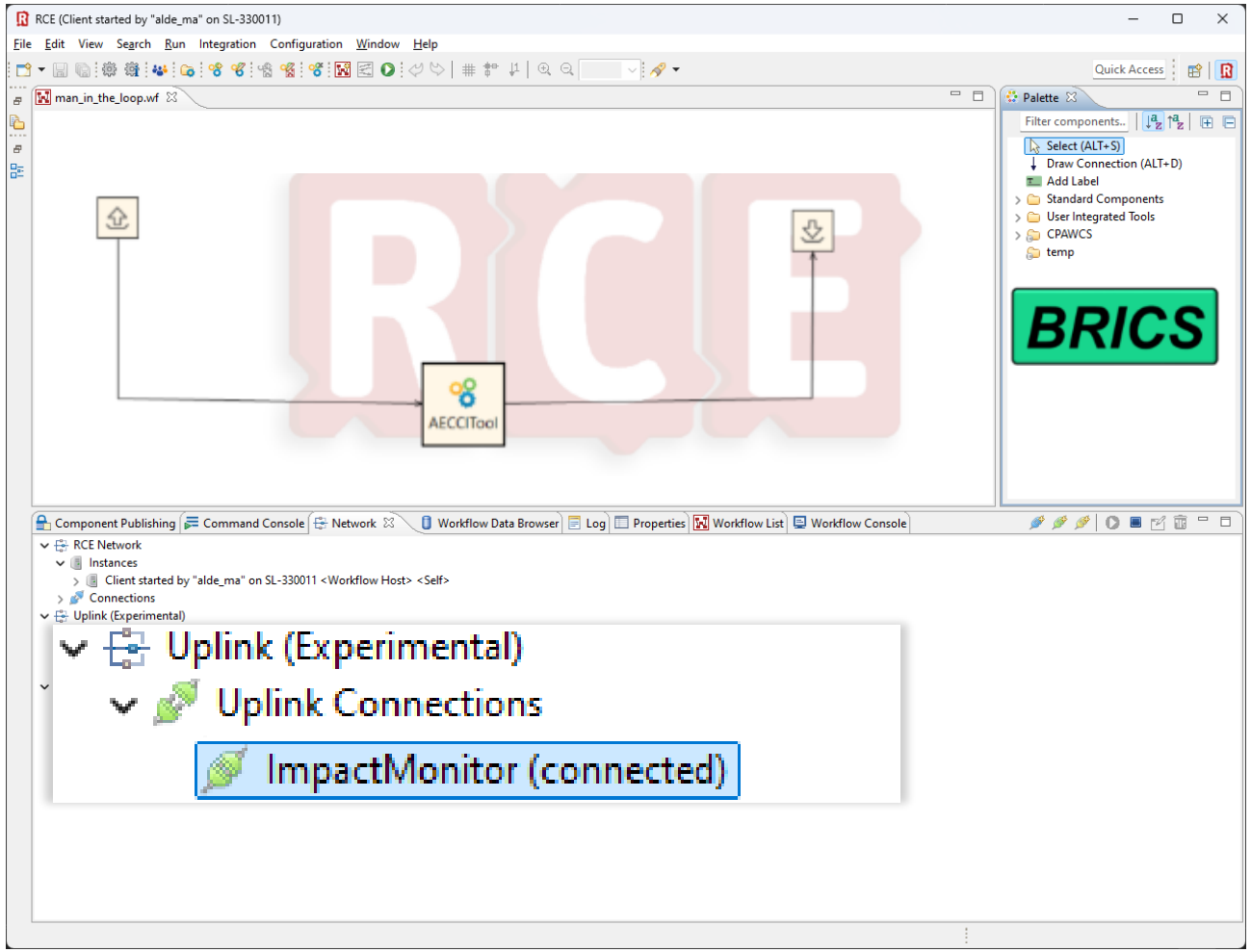


Implementation: Remote Workflow Execution



RCE for workflow integration

- Tutorials for CPACS connection and local RCE integration
- Uplink (experimental)
  - Remote server with 2-level security
- BRICS
  - NLR development with focus on security and man-in-the-loop



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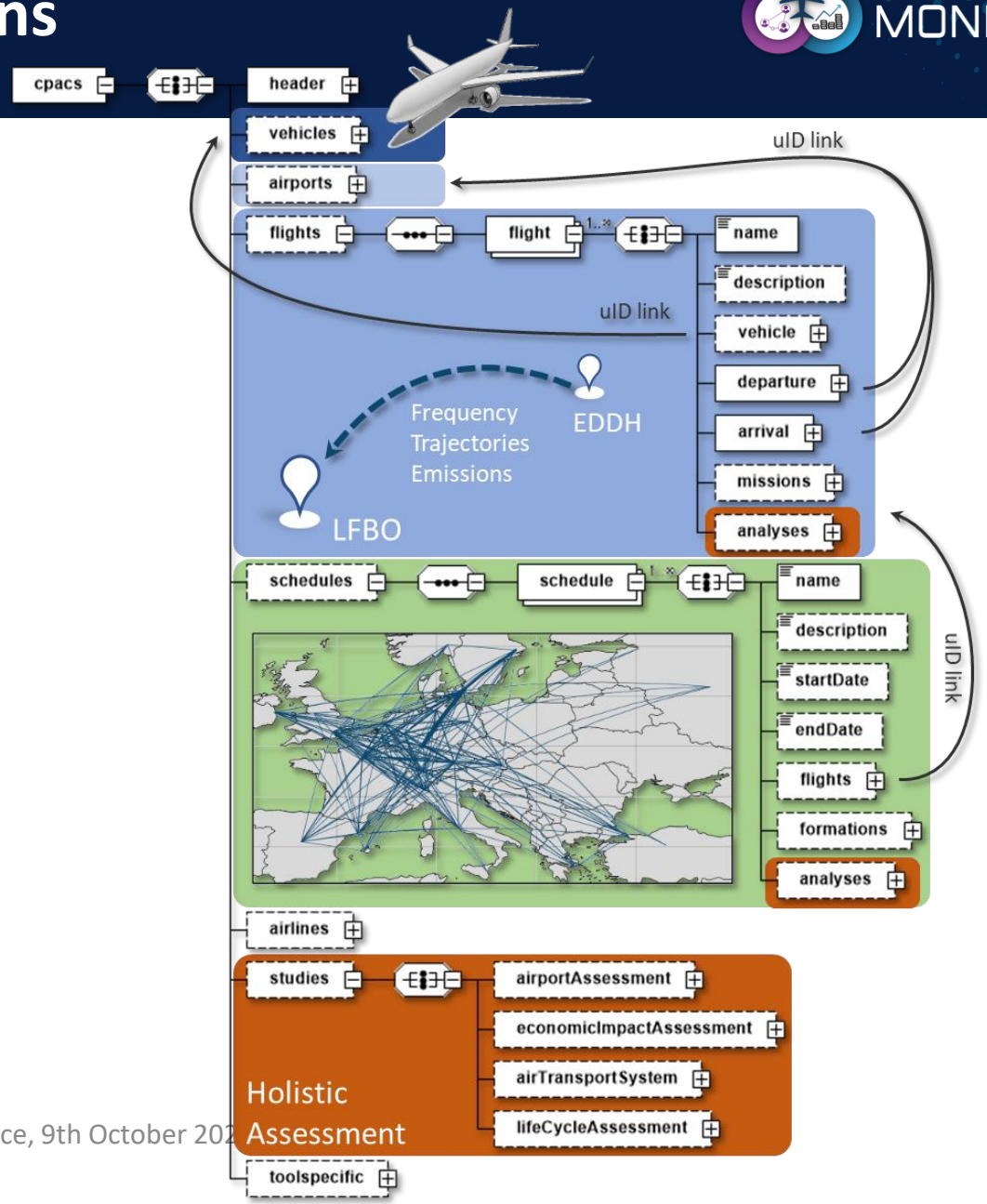
Implementation: Data Schema Extensions

Modification & extension of CPACS

- Schema based on CPACS v3.4
- CPACS schema extended:
  - Schedules
  - Flights
  - Missions
  - Airports
  - Studies



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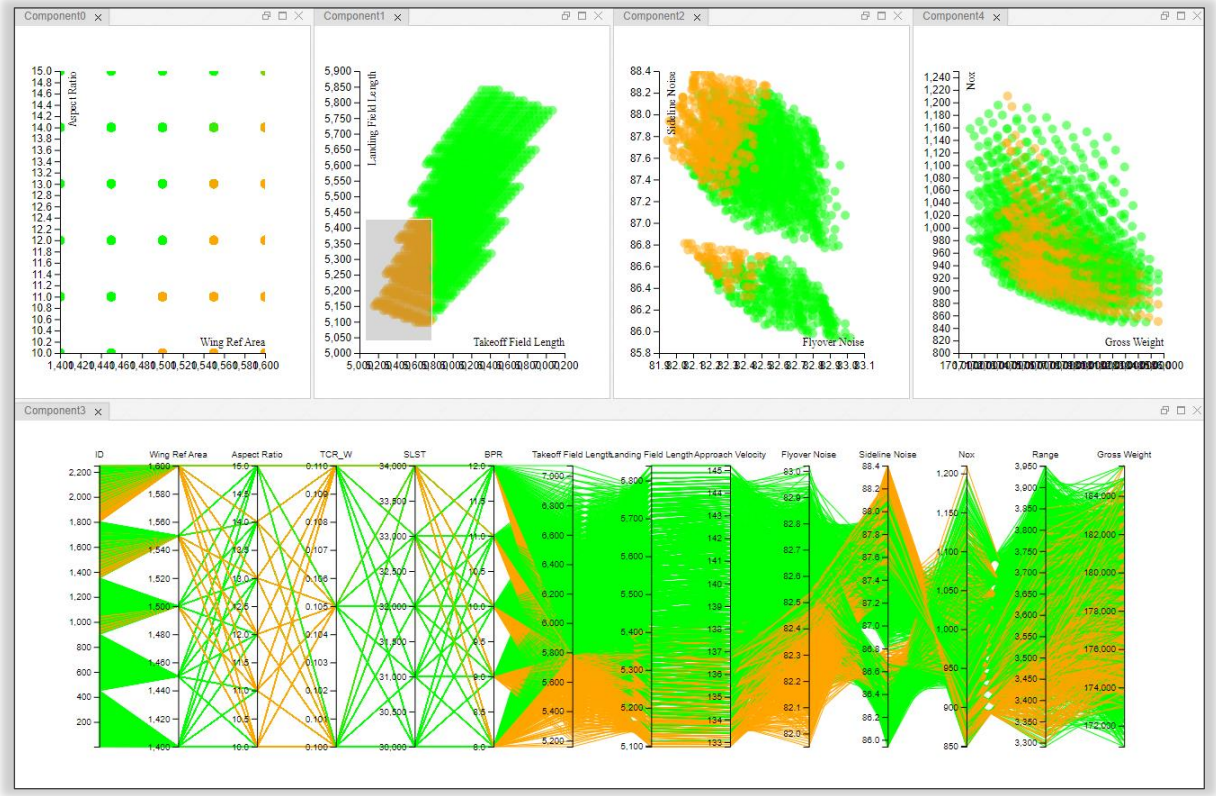
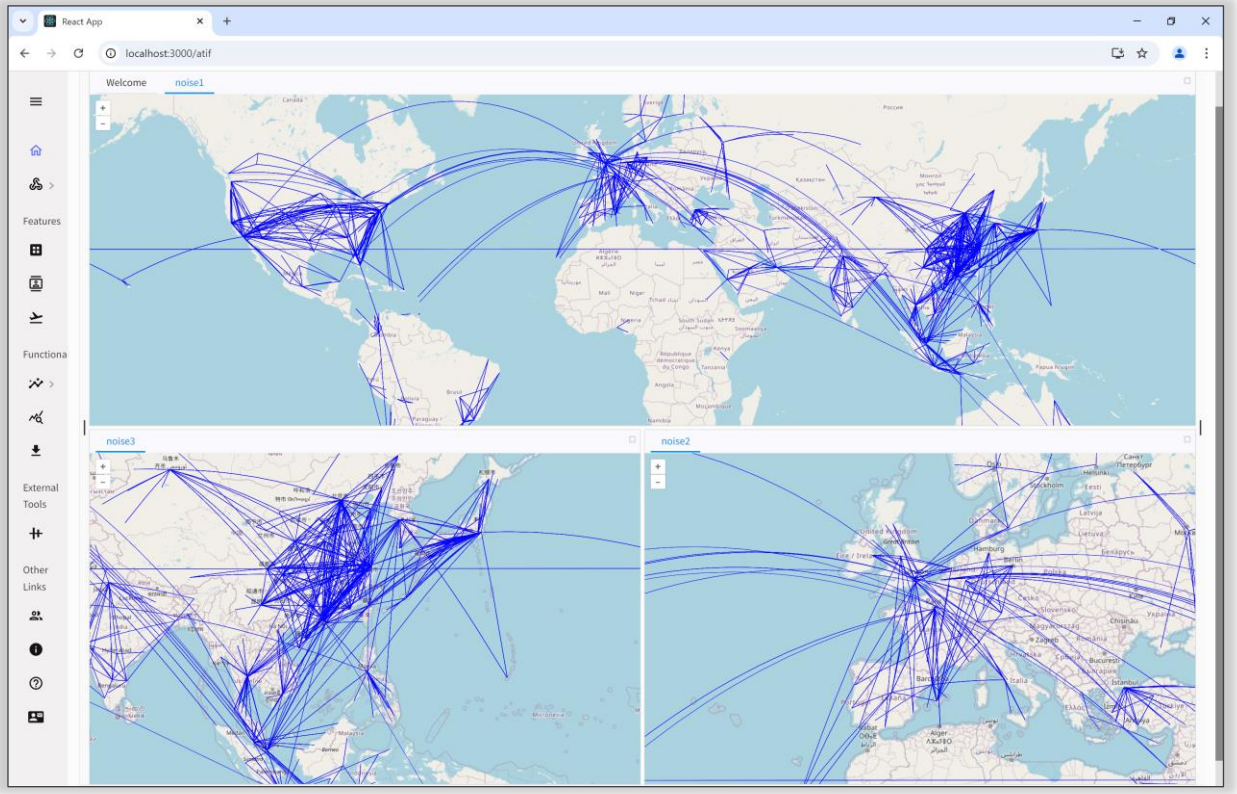
Implementation: Interactive Visual Data Analysis





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Conclusions

Conclusions

Achievements

- Framework **requirements** collected → **architecture** designed → **implemented**
- **MDAx successfully applied** in large and heterogenous project team
- Major **extensions to CPACS** data model (especially ATS level)
- Remote connections via **Uplink successfully tested** in practice

Lessons Learned

- CPACS connection requires some **initial development effort** from tool owners
- CPACS should only be used to **exchange data**, not as a container for all tool data
- **Tutorials** support tool integration, but **requires precise description**

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Conclusions

Future Work

- Finalize implementation (data schema, workflow execution and dashboard)
- Test cross-platform workflow execution with BRICS and RCE
- Fine-tune and make concept available for future application and extensions

IMPACT MONITOR

Thank you!

Dr. Marko Alder (marko.alder@dlr.de)

German Aerospace Center (DLR)

Institute of System Architectures in Aeronautics, Hamburg

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