

# LINKING DIGITAL TWINS TO USE TIME SERIES FOR PREDICTIVE MAINTENANCE AT COMPONENT LEVEL

AVT 369, Båstad, Sweden, 10.10.2023

Presented by H. Meyer

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# MOTIVATION



# Technical Motivation

Predictive maintenance techniques are designed to help determine the condition of in-service equipment in order to estimate when maintenance should be performed. This approach promises cost savings over preventive based maintenance.

## Challenges:

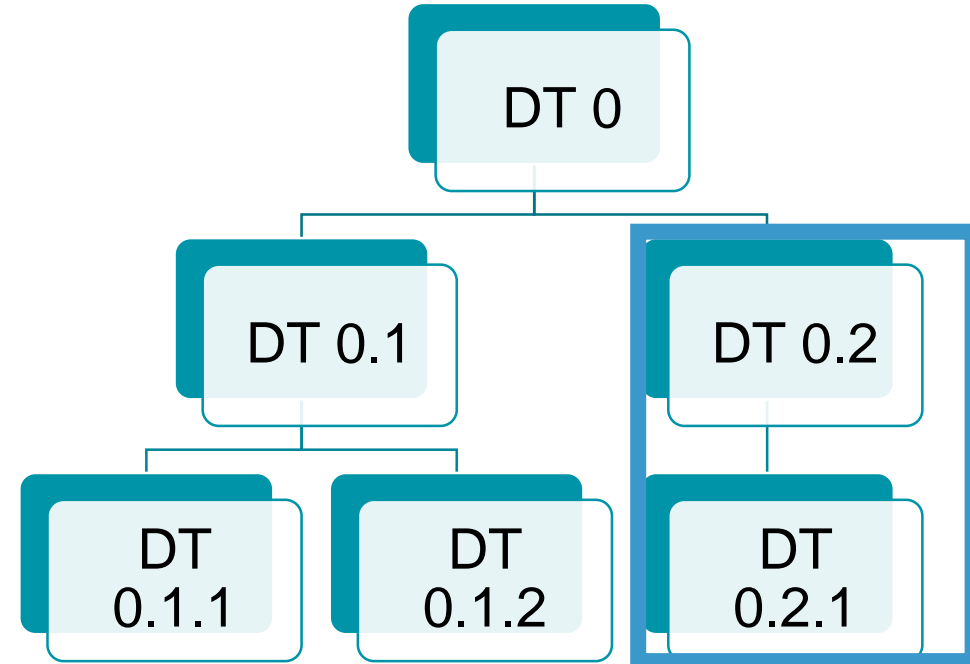
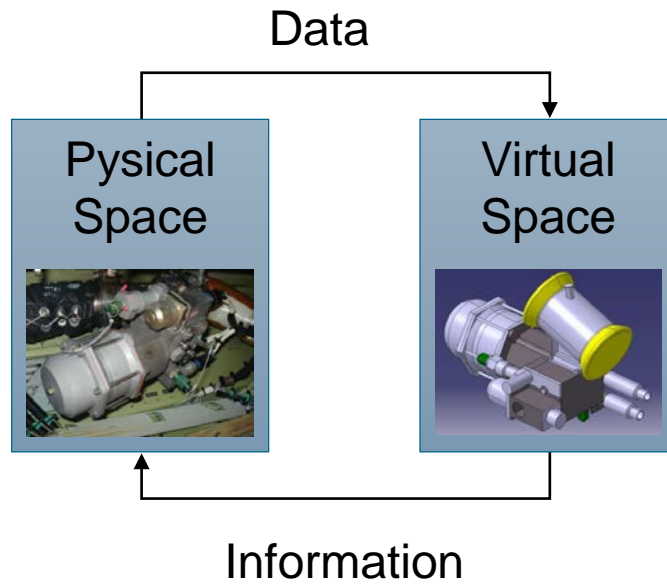
- Data availability
- Accuracy
- Integration in Maintenance
- Reduction of uncertainties
- Identification of impact on logistics
- Analysis of operational costs





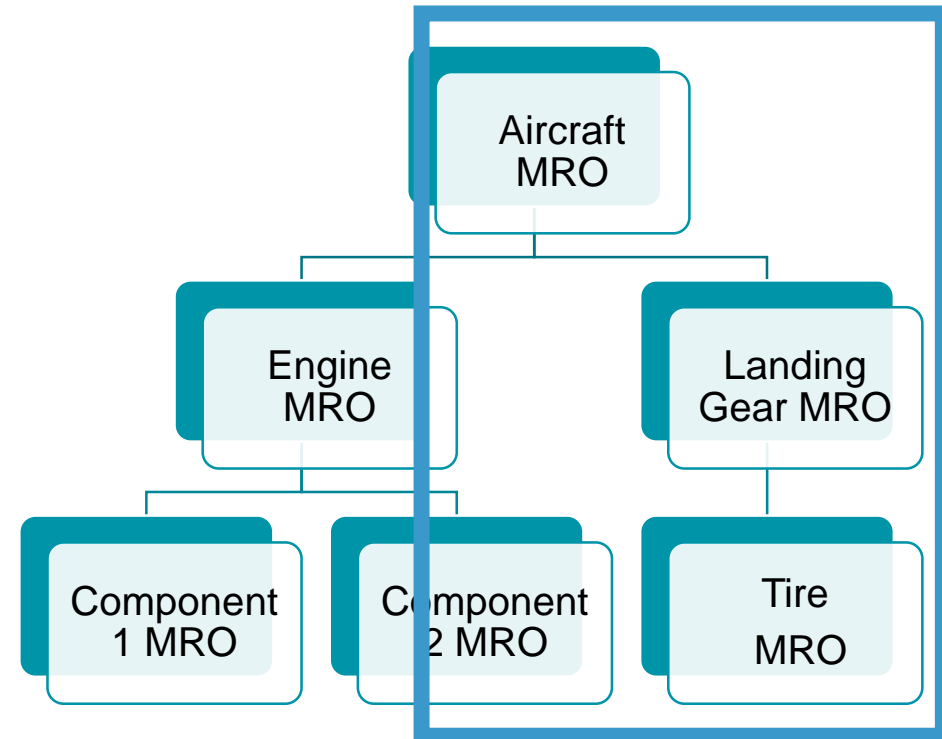
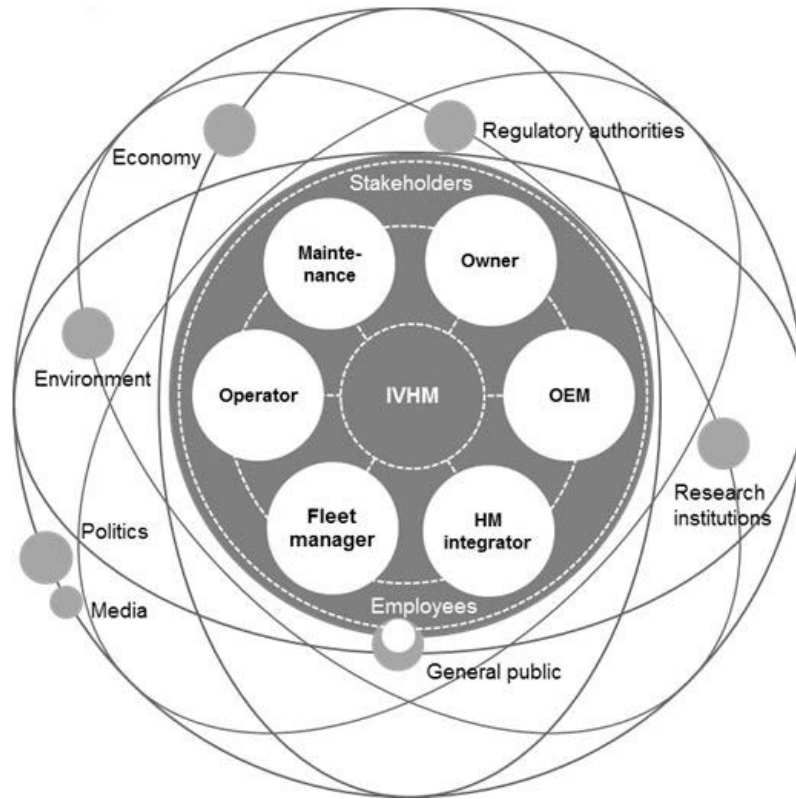
# INTRODUCTION

# Digital Twin





# Stakeholder

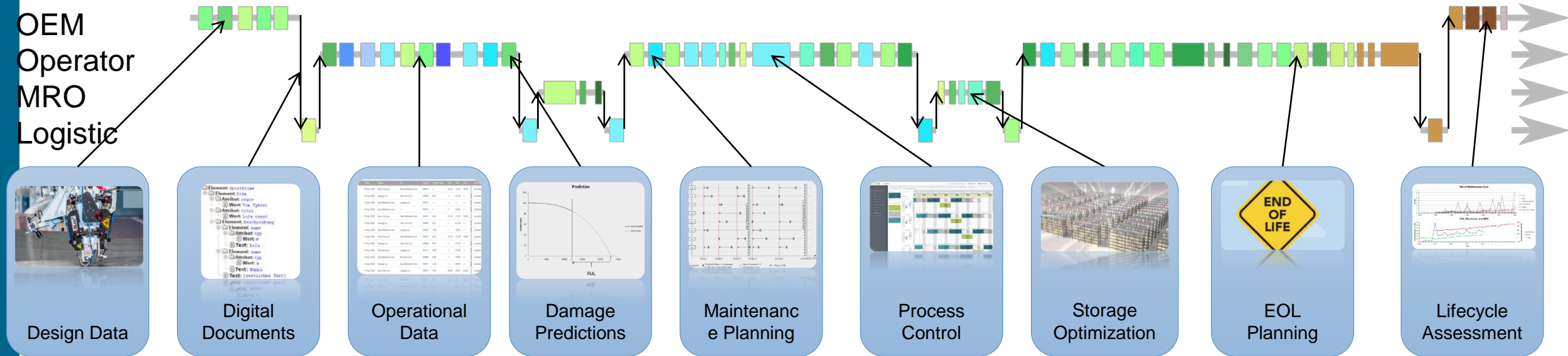


Main Stakeholder regulated by EASA/FAA

# Digital Thread Component

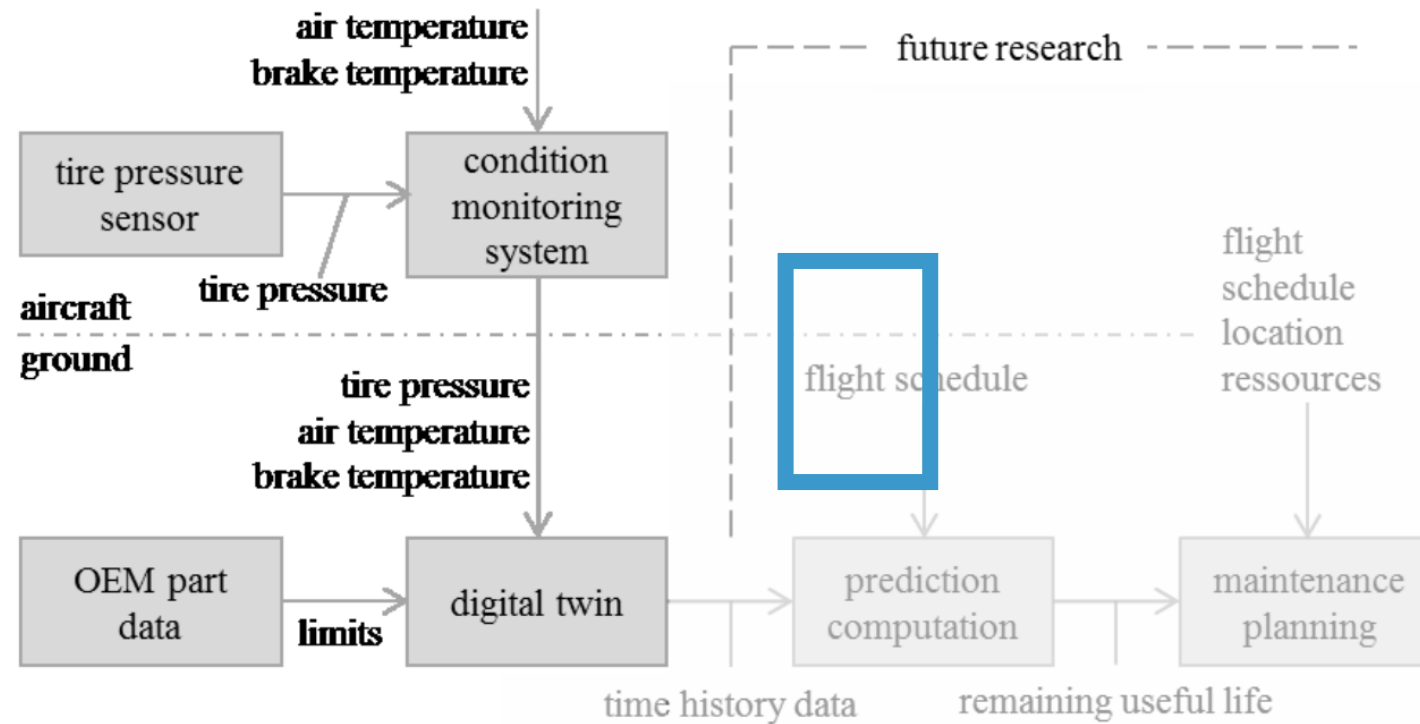


OEM  
Operator  
MRO  
Logistic



Digital Twins with Stakeholder Interactions needed.

# Use Case



Digital transformation in maintenance on the example of a tire pressure indicating system, Meissner et al., AST 2019

- Position?
- Parameter?
- Unit?

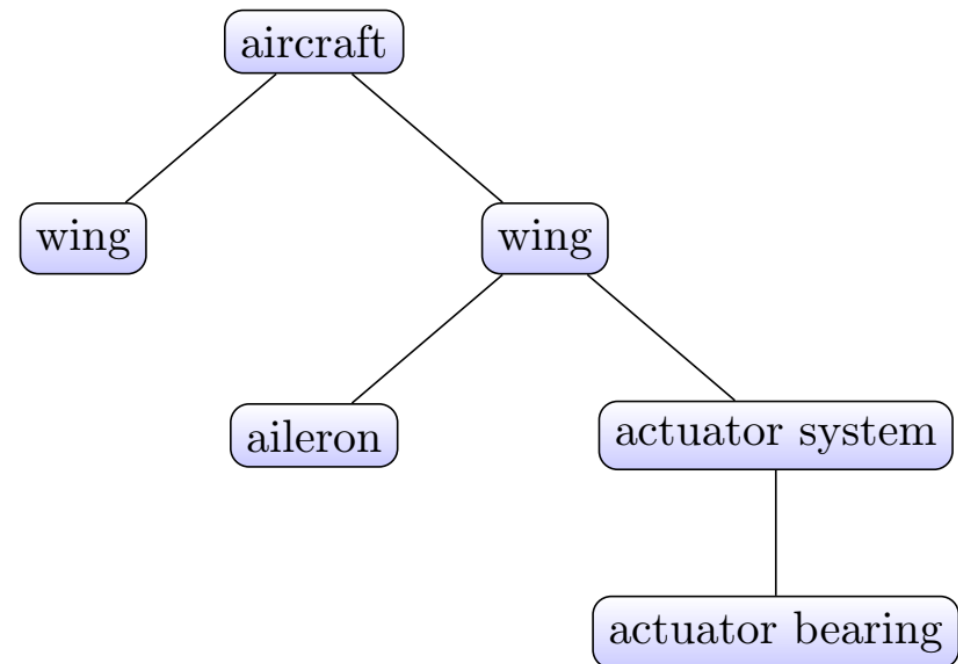
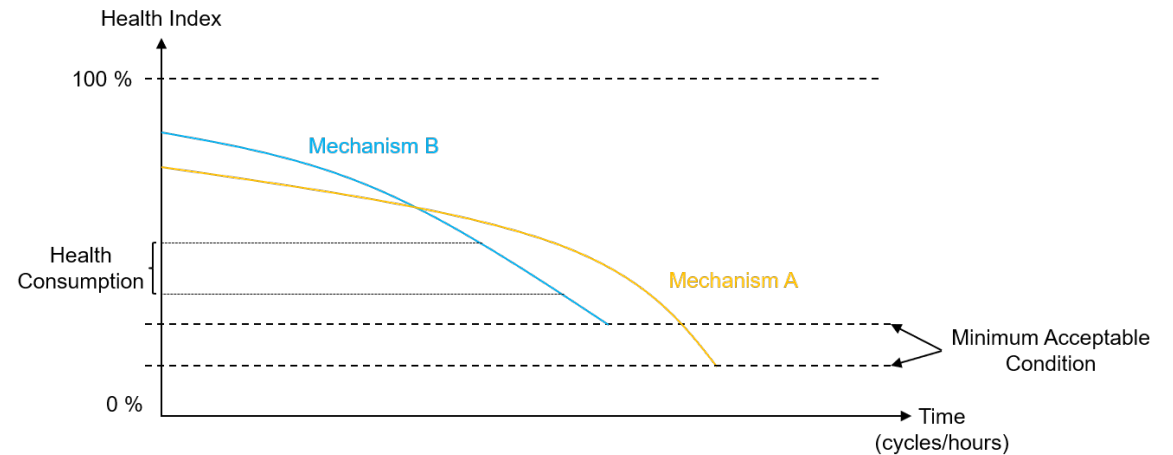
ID's needed



# Health Index

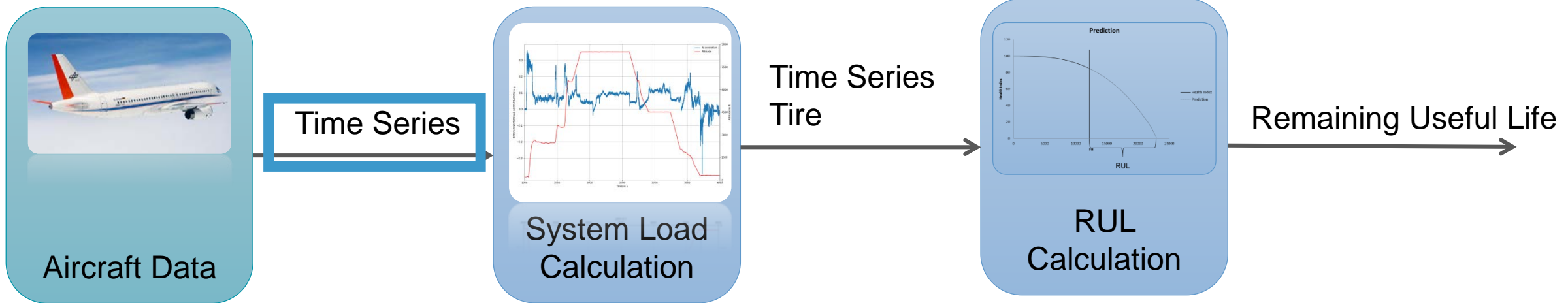
- Health condition expressed by Health Index
- One Health Index per wear mechanism
- Each Health Index has reference value, e.g. maximum number of load cycles or max. temperature value
- Group of health indices can be summarized by superordinate HI
- Time progression of HI expressed by wear correlations depending on different parameters

$$hi = \frac{\text{current state parameter value}}{\text{reference parameter value}}$$



# Remaining Useful Life Workflow

- Workflow for residual life calculation (RUL) of selected components based on real flight data.

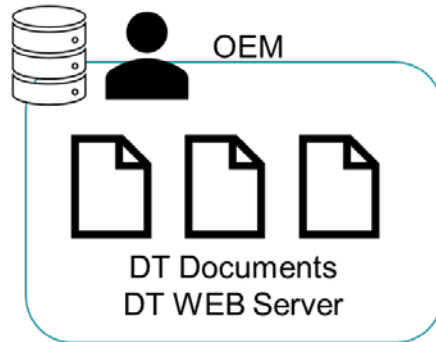




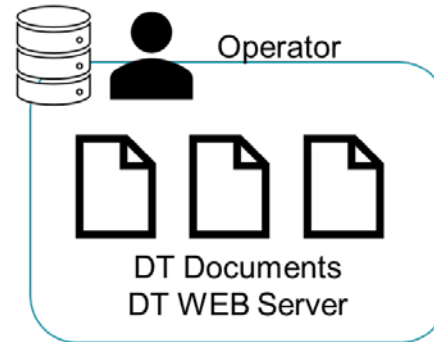
# CONCEPT

Hendrik Meyer, 15.09.2023

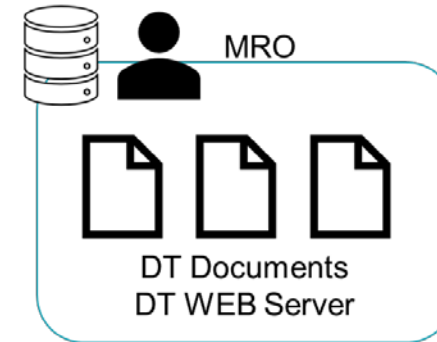
# Data Interaction



Component Integration

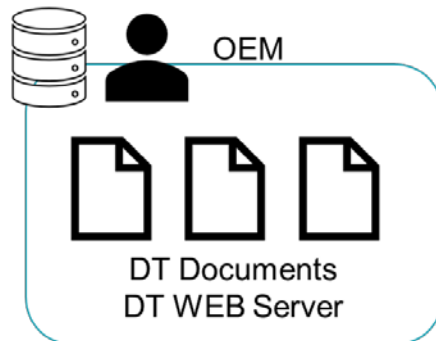


Timeseries

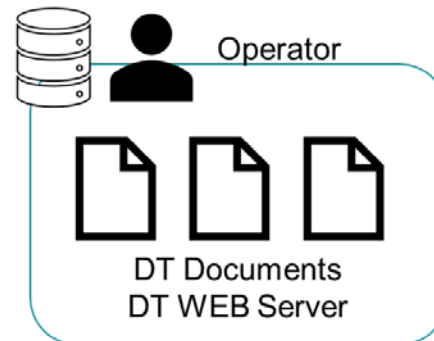


Component Installation / Removal

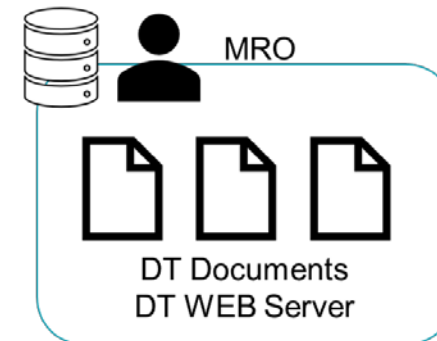
Aircraft  
Component



Component Design



Component RUL  
Calculation

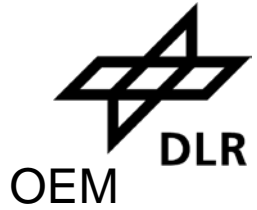


Component Maintenance



# Distributed Digital Twin

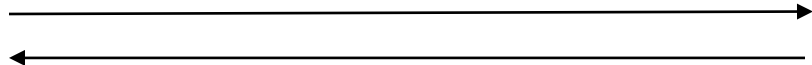
DT Registry  
Trustee (e.g. IATA/ICAO)



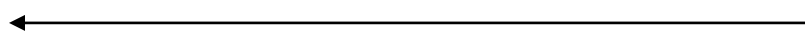
DT User (e.g. Prognostics Services)



Request UID



Answer List of Collections

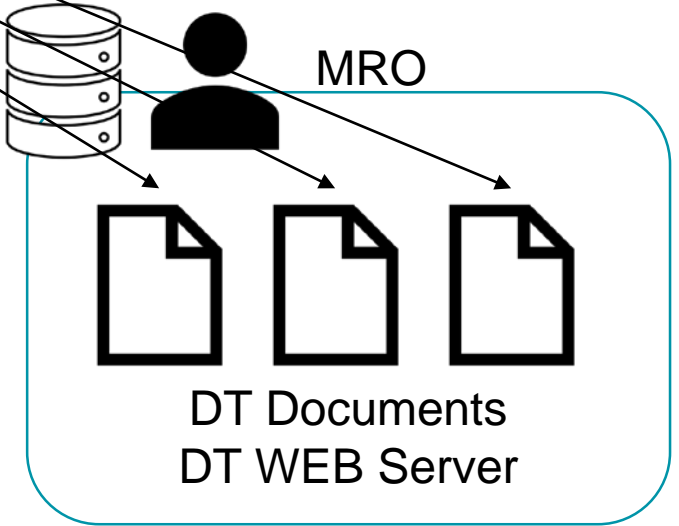
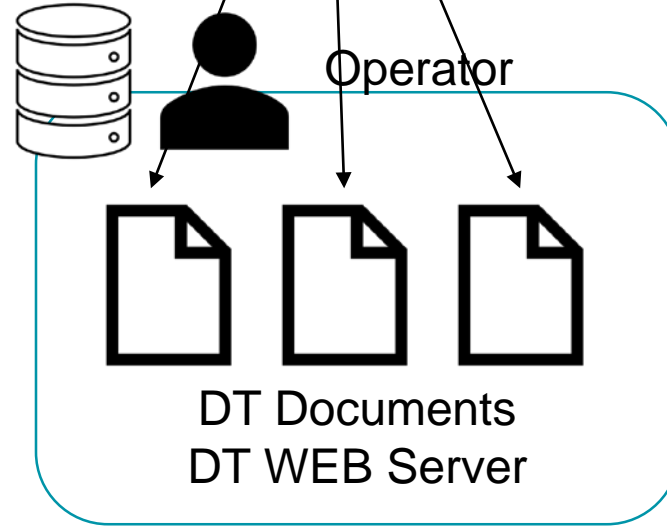
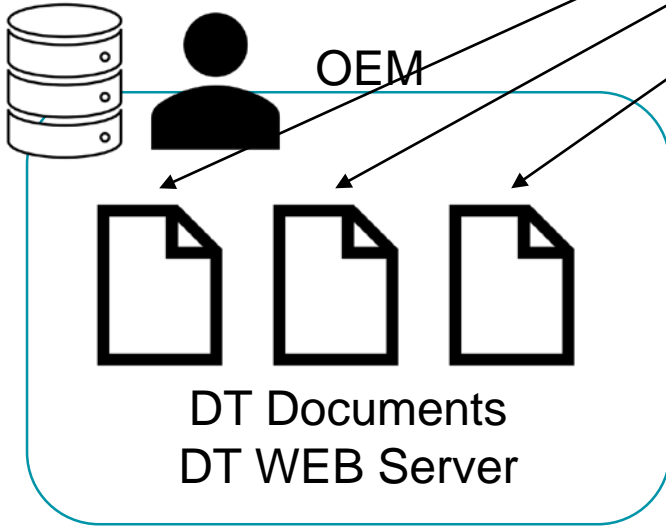


DT Registry

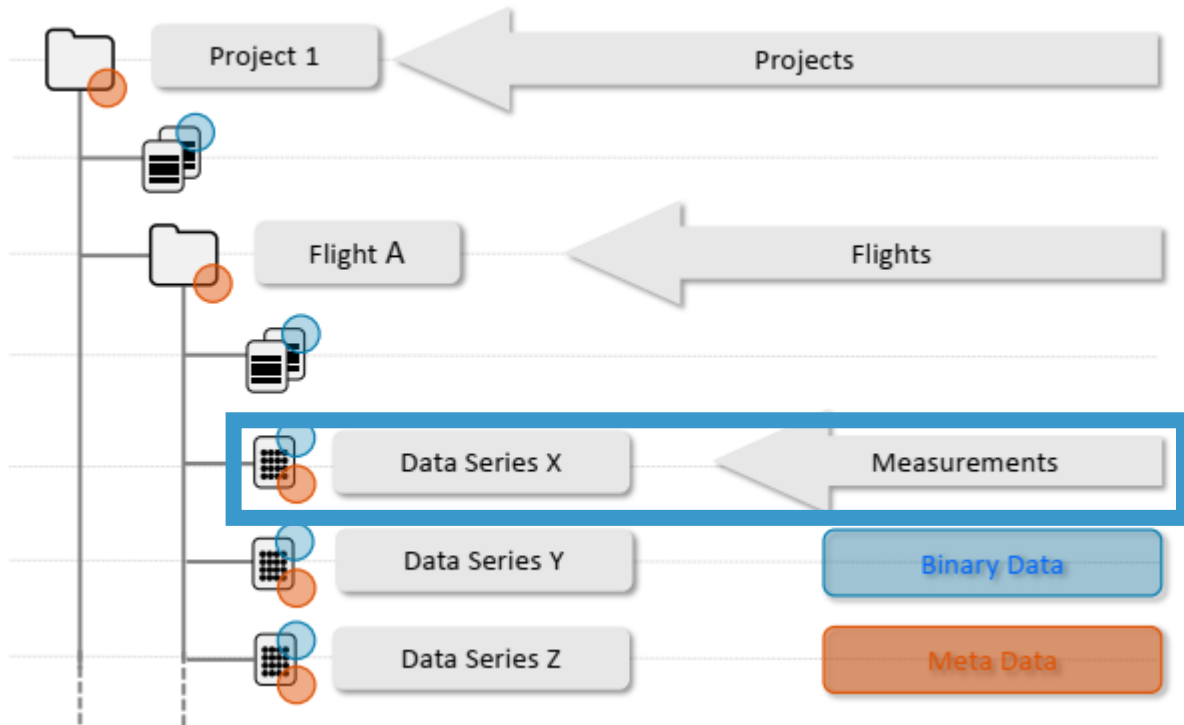
Initialization of DT



```
UUID Component: de710a84-46bb-47a0-  
a563-06eb6266155f  
UUID Data Set:ec2cba2b-705a-4f81-b772-  
df934efb9f19  
IP Address first Data Set: 126.58.78.219  
Data Type: Design Data  
Stakeholder: Design Company  
Date: 24.05.2020
```



# Digital Twin Aircraft



```

type: project
id: 617707c18169c370c15c6aa7
name: DigECAT

user_tags:
  description: Project DigECAT
  participating institute: FX
  project engineer: MT

created_at: 2021-10-25T19:38:41Z
created_by: baes_mi
    
```

```

type: series
id: 617707d88169c370c15c6c77
name: geoaltitude

parent: 617707d68169c370c15c6c4f
data_id: 614191cc44ca142e54e3f0cb

unit: m
series_connector: id: scid_69c5c6c50
representation: height

user_tags:
  logical_source:
    bus: 141754
    channel: 27
    sensor: _2833562C01
    format: BNR
    update_rate_hz: 25
    dev_firmware: v2.3
    pos_sense: up
    
```

```

type: flight
id: 617707d68169c370c15c6c4f
name: FLIGHT_00054_2017
parent: 617707c18169c370c15c6aa7

user_tags:
  experiment: EX192-631
  pilot: Smith
  platform: ATRA
  reference_system: WGS84
  signal_type: bus
  icao: 3c5192
  registration: D-ADLR
  start_utc: 2017-02-22T08:24:42Z
  stop_utc: 2017-02-22T10:49:14Z

created_at: 2021-10-25T19:39:02Z
created_by: baes_mi
    
```

```

statistics:
  max: 14325.6
  mean: 8671.804642568426
  median: 7886.700000000000
  min: 624.84
  nans: 0
  size: 8659
  std: 4394.061706633204

created_at: 2021-10-25T19:39:06Z
created_by: baes_mi
    
```



# CONCLUSION

# Challenges



- In the first use case manual linking of data
  - Standardization of data identifiers required for automation
- In the first use case no user rights management on parameter level
  - Access rights management at parameter level necessary
- Digital Twin Concept for the whole aviation industry needed
  - First approaches available (Industry 4.0, Digital Twin Web)
- Requirements on data quantity and quality based on use case
  - Design concept needed for digital twin interaction



# Impressum



Thema: **Digital twin concept for components: Interaction with aircraft time series data**

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Autor: H. Meyer, A.-K. Koschlik, F. Raddatz

Institute: Institute for Maintenance Repair and Overhaul

Picture

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