

The background of the slide is an aerial photograph of a vast mountain range, likely the Alps, with snow-capped peaks and deep valleys. The sky is a clear, bright blue. A small orange horizontal line is positioned above the title text.

# SYSTEMS ENGINEERING – CLASSICAL VS. MODEL BASED APPROACH AND FIRST LESSONS LEARNED

22.11.2022  
K. JESSWEIN  
M. BRAHM

# AGENDA

---



1. Problems of document-based systems engineering
2. Model-Based Systems Engineering Method
3. Lesson's Learned from QKD Pilot Project
4. Future Challenge

1

# PROBLEMS OF DOCUMENT-BASED SYSTEMS ENGINEERING

# MISSING OR UNCLEAR SEMANTICS

## PROBLEMS OF DOCUMENT-BASED SYSTEMS ENGINEERING



### Text-based requirements

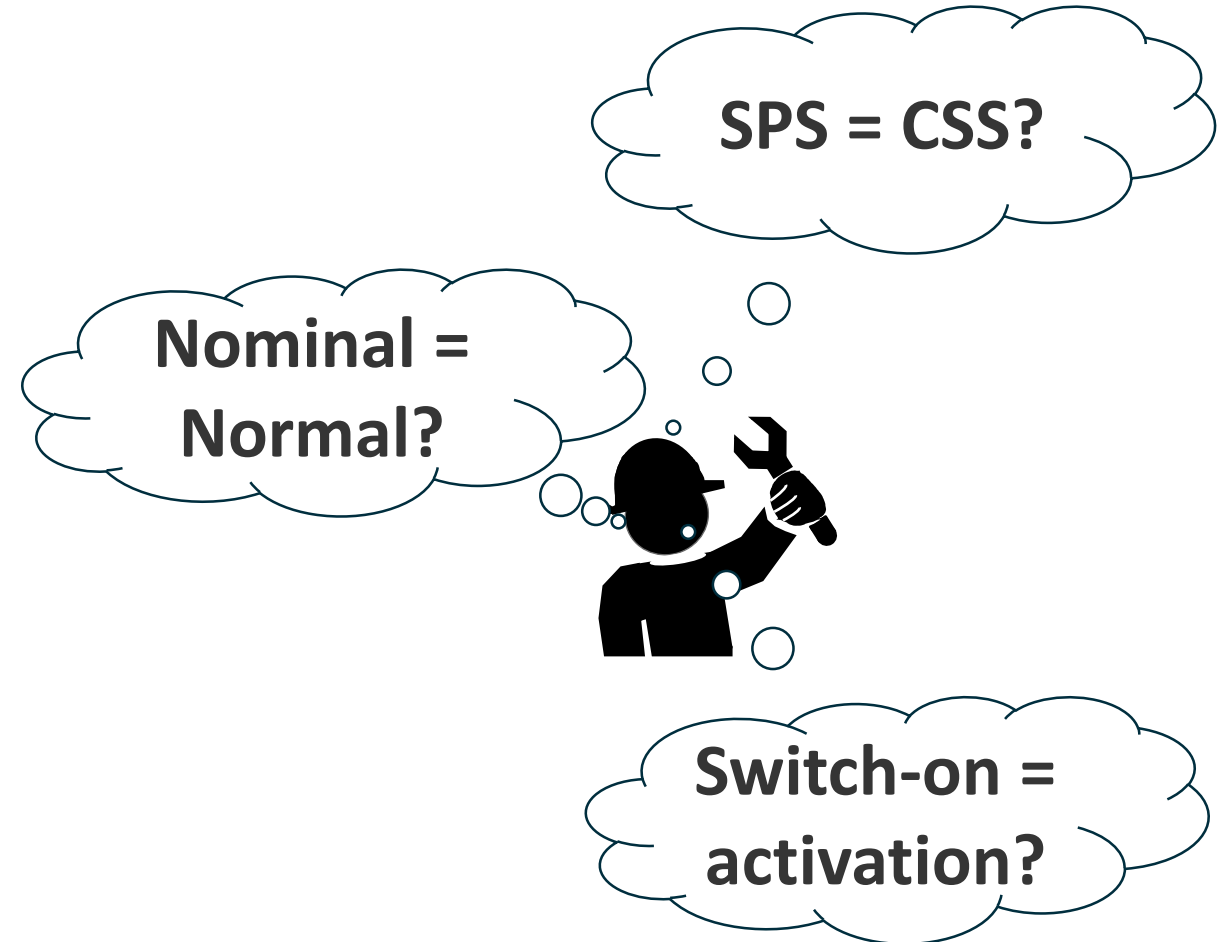
ID	Object Text
RQ-101	When entering the <b>NM</b> the <b>CSS</b> shall be activated.
RQ-202	Upon ground TC, the satellite shall enter the <b>normal mode</b> .
...	...
RQ-504	When switching on the <b>SPS</b> , its HK telemetry shall be acquired.

# MISSING OR UNCLEAR SEMANTICS

PROBLEMS OF DOCUMENT-BASED SYSTEMS ENGINEERING

## Text-based requirements

ID	Object Text
RQ-101	When entering the <b>NM</b> the <b>CSS</b> shall be activated.
RQ-202	Upon ground TC, the satellite shall enter the <b>normal mode</b> .
...	...
RQ-504	When switching on the <b>SPS</b> , its HK telemetry shall be acquired.



# MISSING OR AMBIGUOUS REALTION BETWEEN REQUIREMENTS

PROBLEMS OF DOCUMENT-BASED SYSTEMS ENGINEERING



## Table-based views

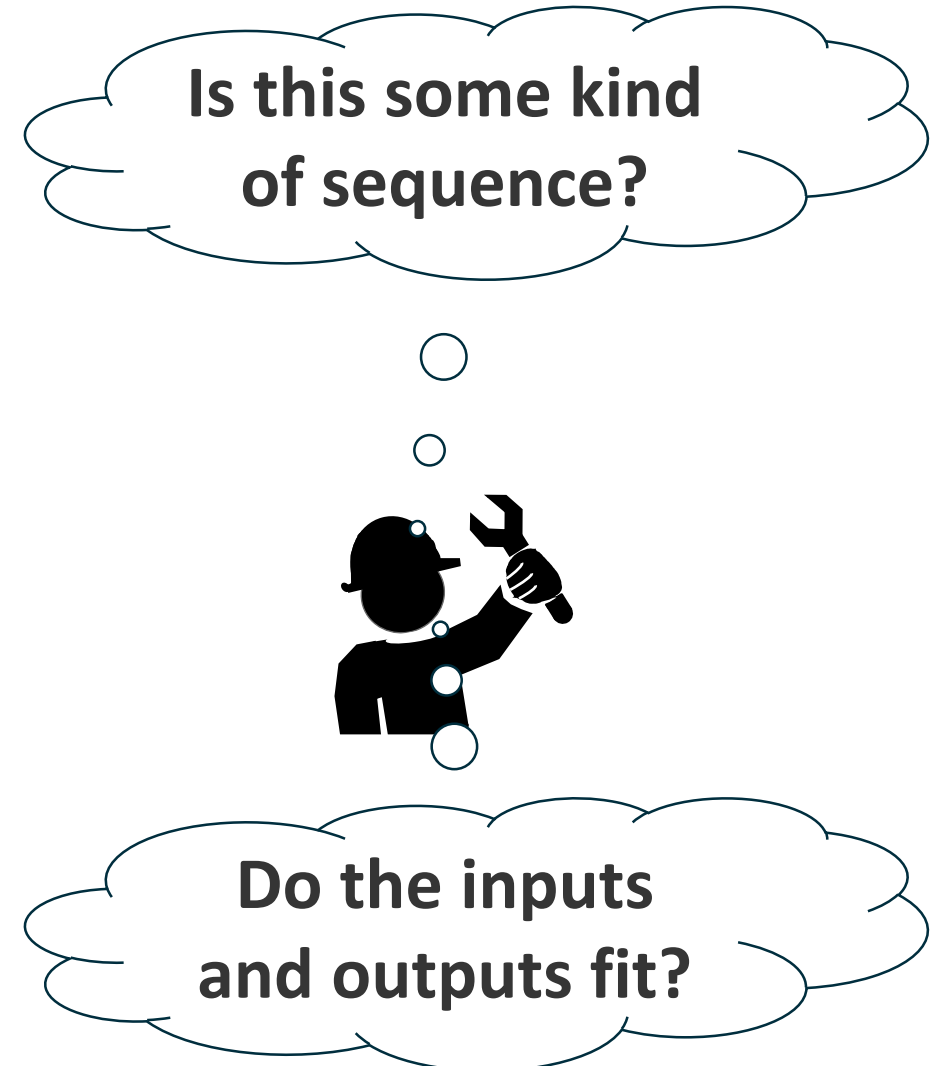
ID	Object Text
RQ-101	When entering the NM the CSS shall be activated.
...	...
RQ-504	<b>When switching-on the SPS</b> , its HK telemetry shall be acquired.
...	...
RQ-327	If the generation of an HK report is enabled, the SC <b>shall periodically provide the HK data</b> which is configured to be part of the report.

# MISSING OR AMBIGUOUS REALTION BETWEEN REQUIREMENTS

PROBLEMS OF DOCUMENT-BASED SYSTEMS ENGINEERING

## Table-based views

ID	Object Text
RQ-101	When entering the NM the CSS shall be activated.
...	...
RQ-504	<b>When switching-on the SPS, its HK telemetry shall be acquired.</b>
...	...
RQ-327	If the generation of an HK report is enabled, the SC shall <b>periodically provide the HK data</b> which is configured to be part of the report.



## Table-based requirements

ID	Object Text
RQ-3232	The TCS Control shall keep the STS temperature between its configurable min and max values.
RQ-3323	The STS temperature min and max value shall initially be set to <b>10</b> and <b>20</b> degrees celsius.

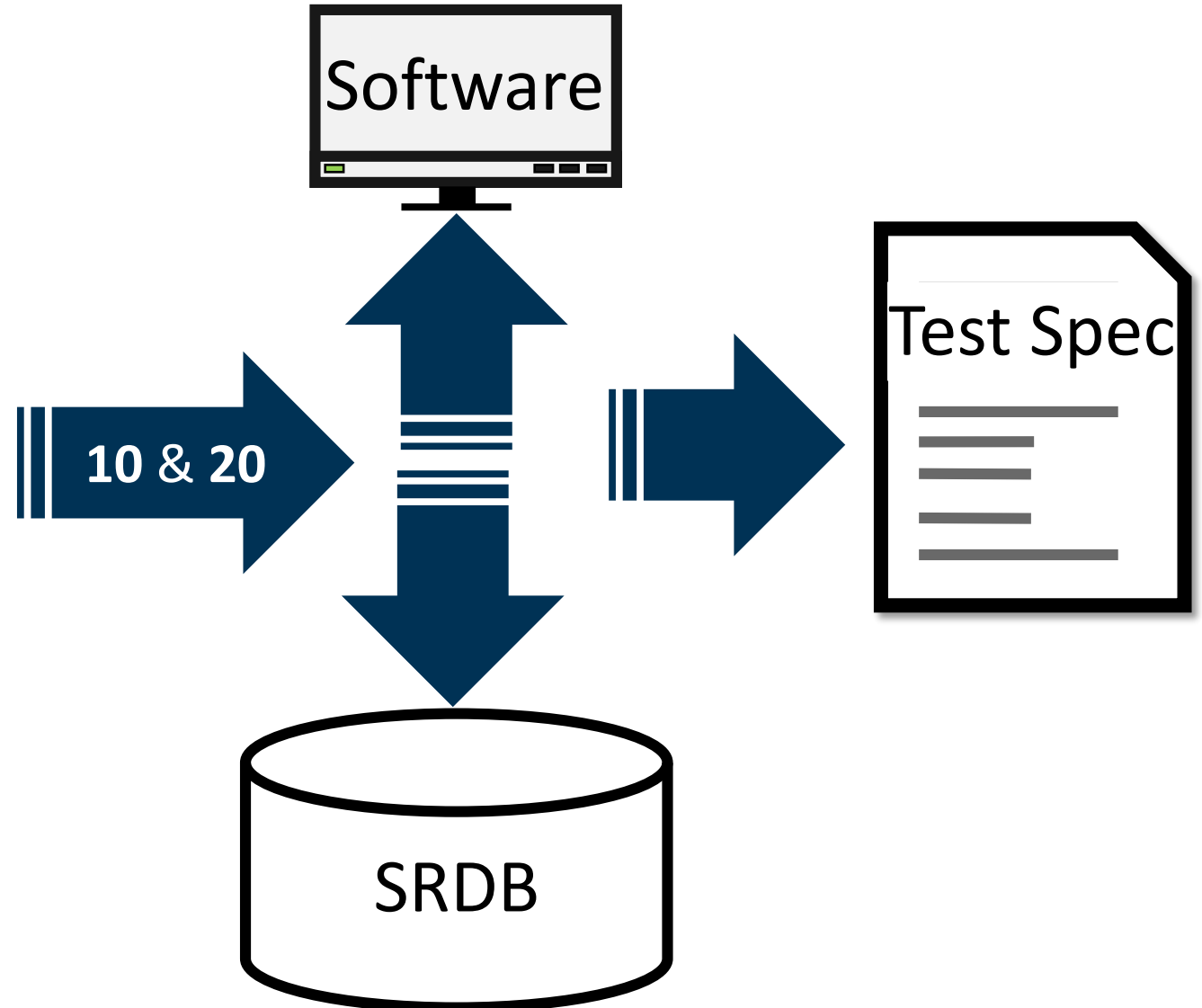


# MISSING DIGITAL CONTINUITY

## PROBLEMS OF DOCUMENT-BASED SYSTEMS ENGINEERING

### Table-based requirements

ID	Object Text
RQ-3232	The TCS Control shall keep the STS temperature between its configurable min and max values.
RQ-3323	The STS temperature min and max value shall initially be set to <b>10</b> and <b>20</b> degrees celsius.

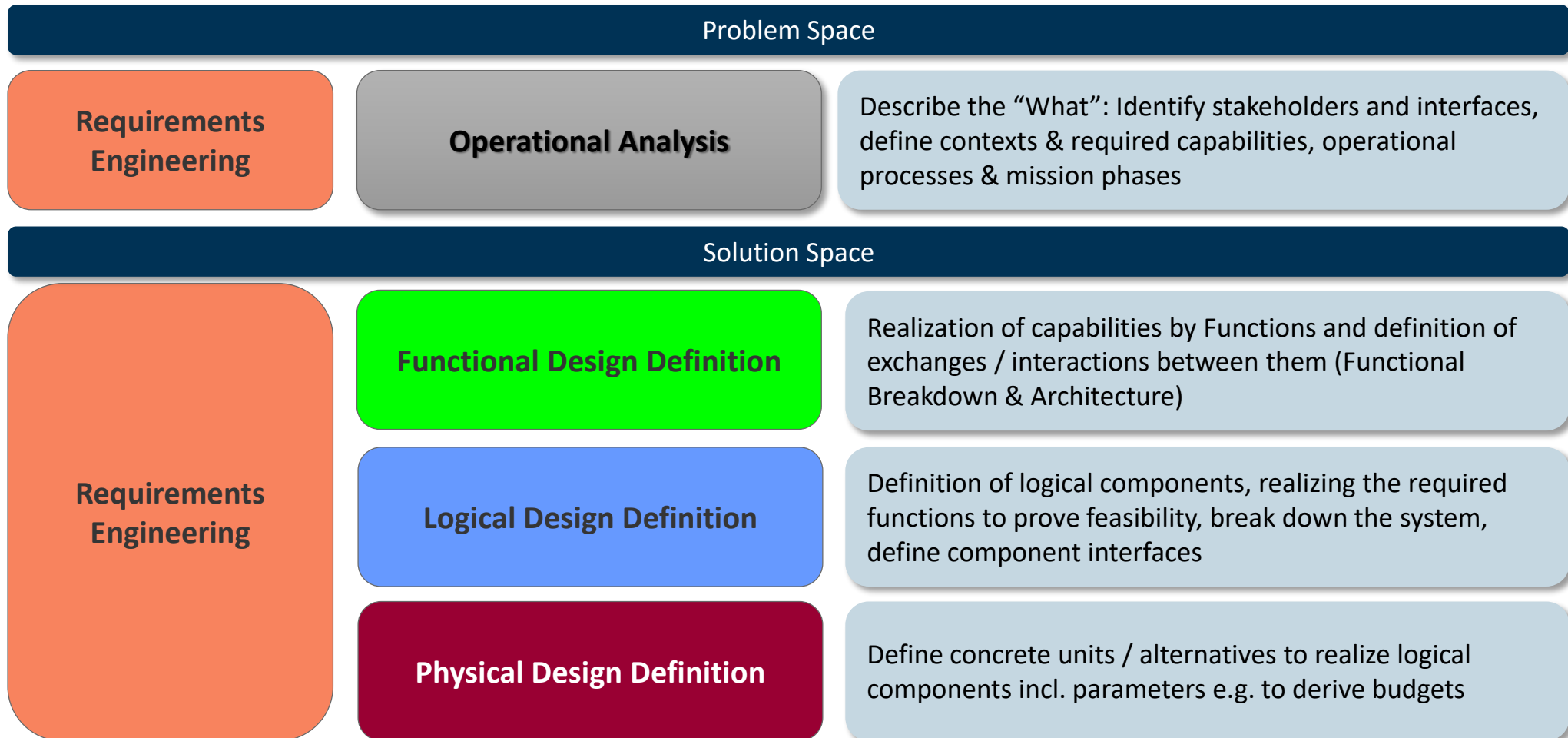


2

# MODEL-BASED SYSTEMS ENGINEERING METHOD

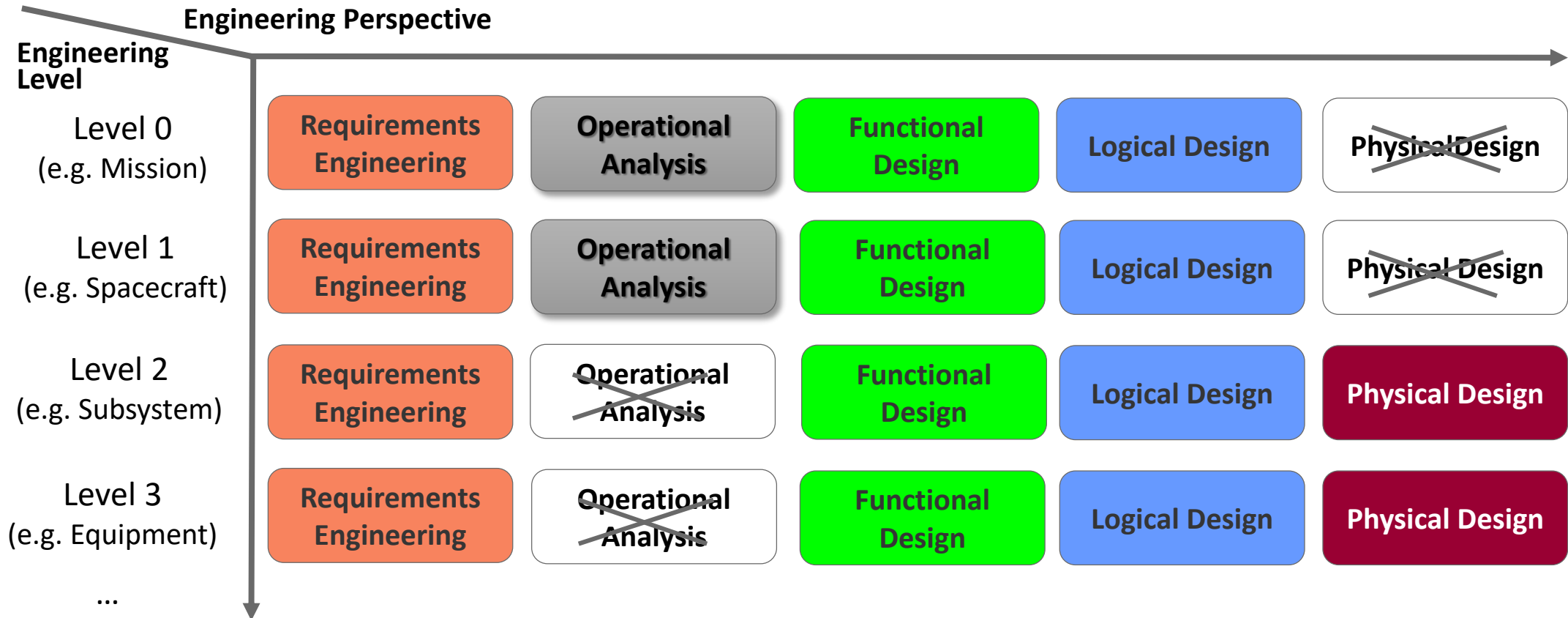
# ENGINEERING PERSPECTIVES

## MODEL-BASED SYSTEMS ENGINEERING METHOD



# ENGINEERING DOMAINS

## MODEL-BASED SYSTEMS ENGINEERING METHOD



Possibility to skip perspectives for certain engineering levels

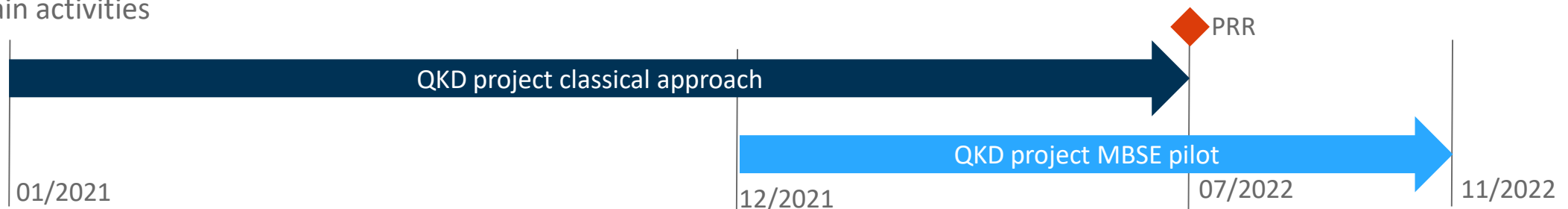
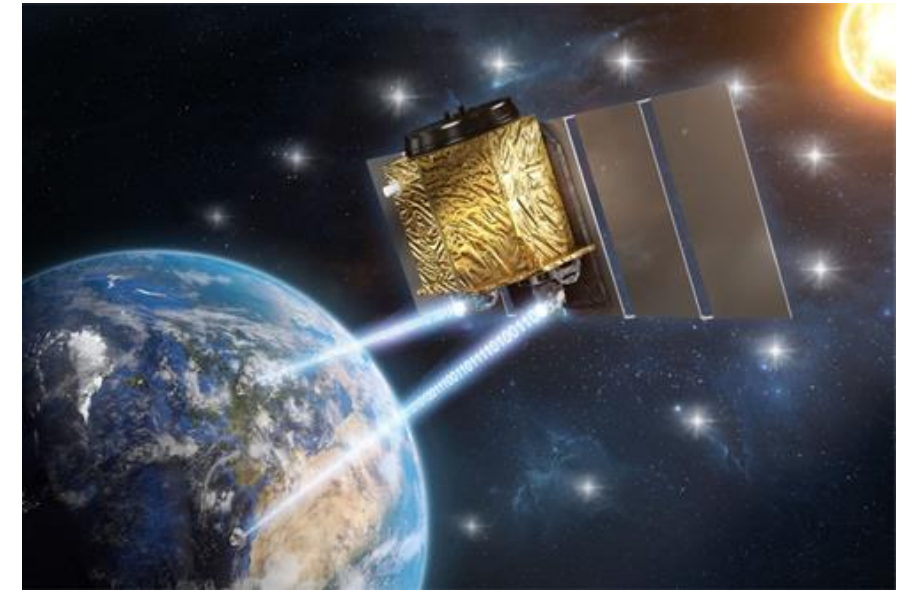
3

# LESSON'S LEARNED FROM QKD PILOT PROJECT

# QKD PILOT PROJECT

## LESSON'S LEARNED FROM QKD PILOT PROJECT

- **MBSE activities** were started in **parallel to the main study activities** (CCN, started Dec 2021)
  - Main project which had been started way before in 01/2021 **was unaffected** (classical approach only)
  - Main project was concluded in 07/2022
  - **MBSE** activities have been concluded in November 2022
  - The team working on the MBSE parts was **the same** as in the main study activities
  - Activities were based on current development of **OHB in-house MBSE methodology and processes (first pilot project)**
  - MBSE work will be **continued in the next project phase** and included in the main activities

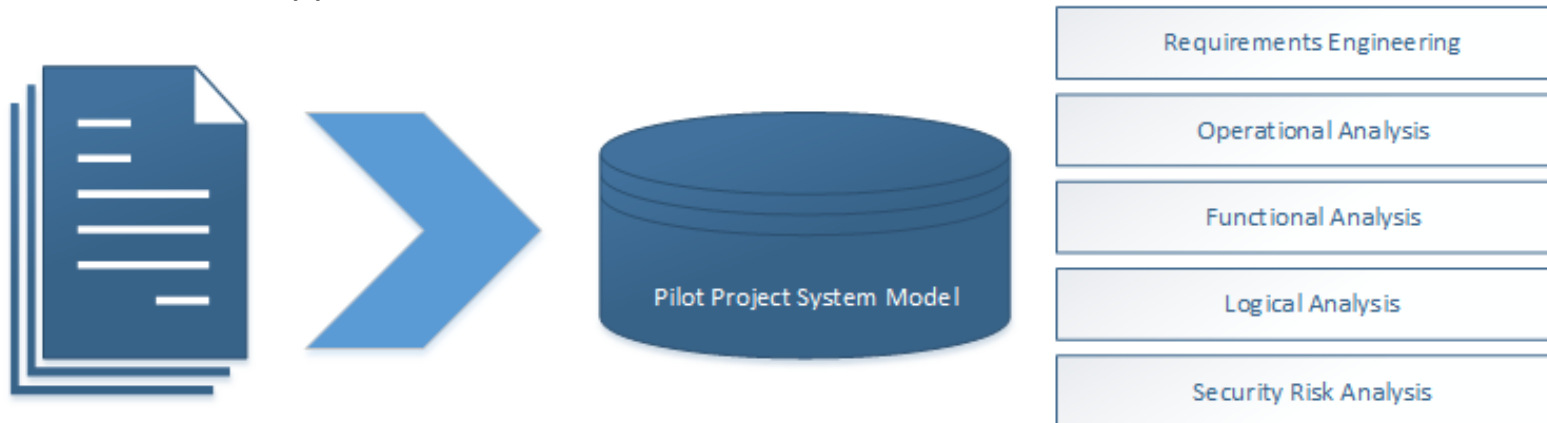


# SCOPE OF WORK

## LESSON'S LEARNED FROM QKD PILOT PROJECT

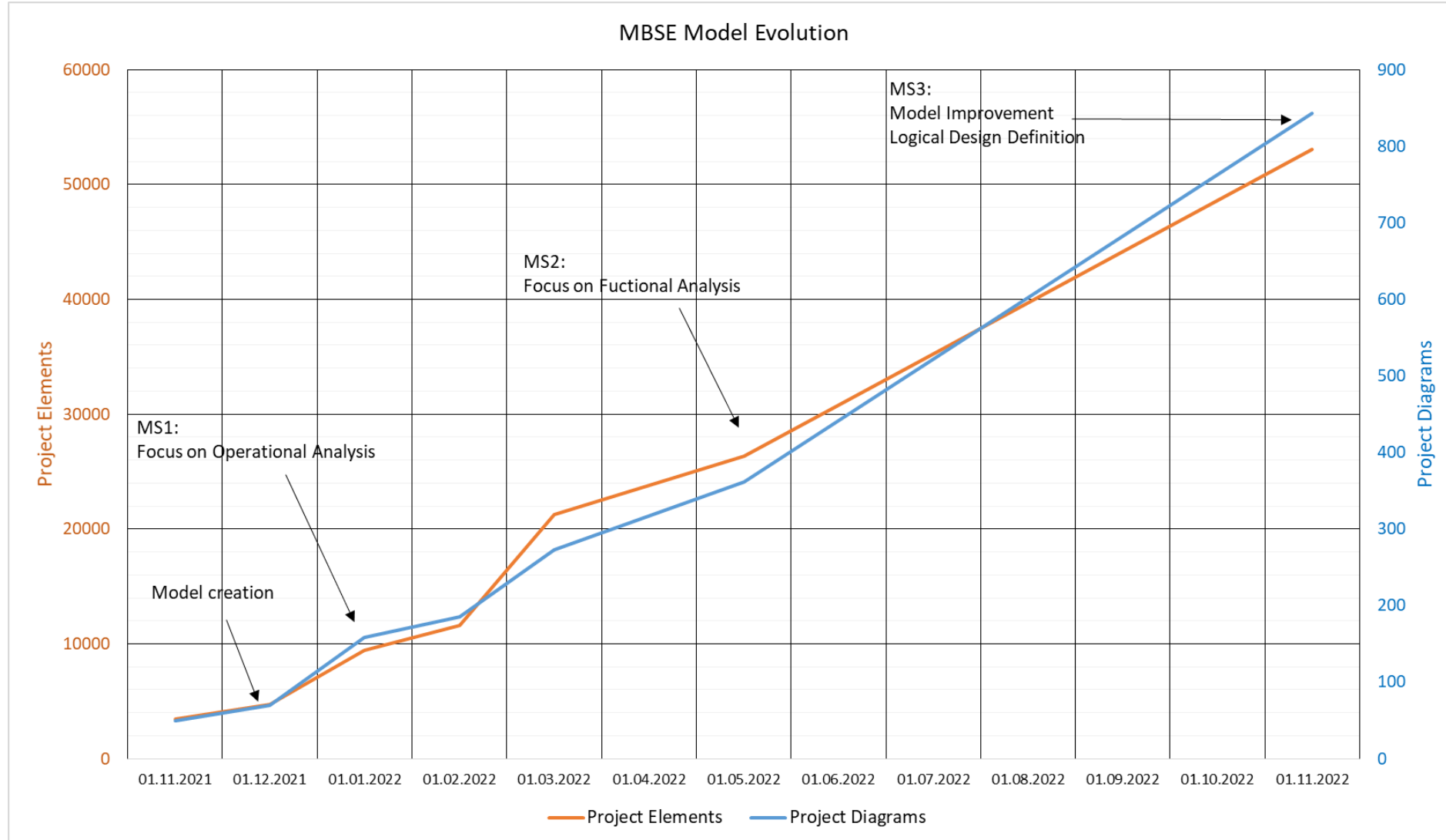
### MBSE Scope:

- **User and System Requirements:** imported from the requirements management tool IBM DOORS
- **Operational Analysis:** elements including the operational contexts under scope, operational entities, exchanged items, and the capabilities with their activities
- **Functional Design Definition:** including the functional blocks and their interfaces and exchanged items
- **Logical Design Definition:** including the logical blocks and their interfaces and exchanged items
- **Security Risk Analysis:** translating the document-based information and tracing it to the logical design
- **Comparison** of classical and MBSE approach + lessons learnt



# MODEL EVOLUTION

## LESSON'S LEARNED FROM QKD PILOT PROJECT





# WHAT WE LEARNED (1/2)

## LESSON'S LEARNED FROM QKD PILOT PROJECT

- **OHB Methodology** could be applied to this project (with close interaction between project and method development)
  - This concerns especially predefined points such as: data structure, data traceability, integration with DOORs

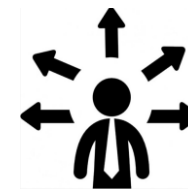


- **What we learned for OHB and the QKD Project:**

- Information can be more consistent and reusable -> however it is tricky when several people are working on the model and **validation rules** are required (to identify missing, empty diagrams or wrong, missing or empty links, ...)



- A need is identified for **variability management** -> study projects do Trade-offs in early phases



- Modelling involves some repeating tasks which can be automatized with an MBSE **Wizard**



- It is recommended to define measurements for comparison of the **classical and the MBSE approach** in advance



# WHAT WE LEARNED (2/2)

## LESSON'S LEARNED FROM QKD PILOT PROJECT

### For the Project

- More time was spent on actually **thinking about the problem** rather than the solution
- MBSE allows to **think more specific** and focus on a certain context -> additional requirements were identified
- MBSE similar to any new competence requires **time and effort to learn it** -> recently new colleagues had 1 week of training before starting to work on the model
- Presentation of the model is different - **which view is suitable for which stakeholder concern?**
- Translation of **information from documents** (and peoples mind) – not always straight forward as information from the documents was not always complete
- It is in near future still required to **link to non-model content** -> i.e. performance analysis documentation
- **MBSE adoption strategy as a hybrid** (in parallel and running with the main project) was difficult -> off-cycle or on-cycle is recommended



4

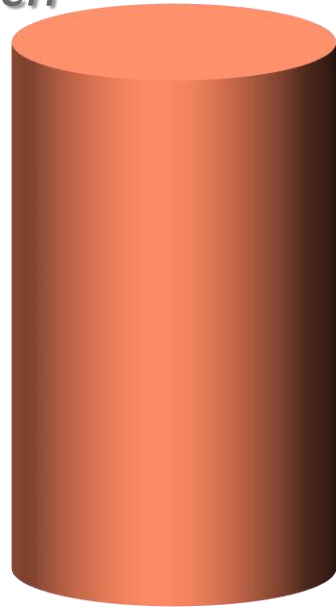
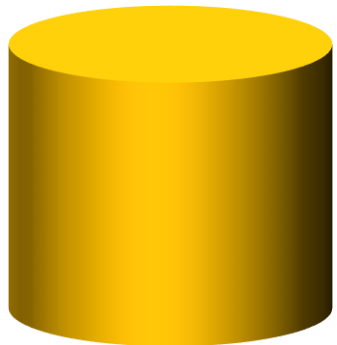
# FUTURE CHALLENGE

# BALANCING ENGINEERING PERSPECTIVES

FUTURE CHALLENGE



*Classical Approach*



Requirements

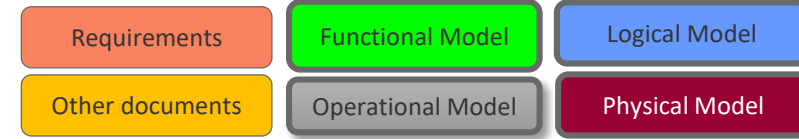
Other documents

*Future Approach?*

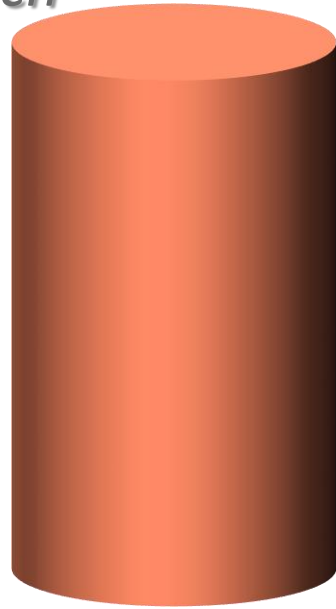
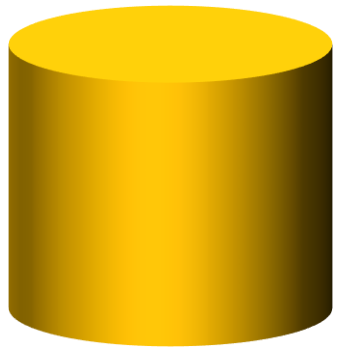
- Relevant Information in natural-language based documents (often, table based)
- Verification activities mostly based on textual requirements

# BALANCING ENGINEERING PERSPECTIVES

FUTURE CHALLENGE

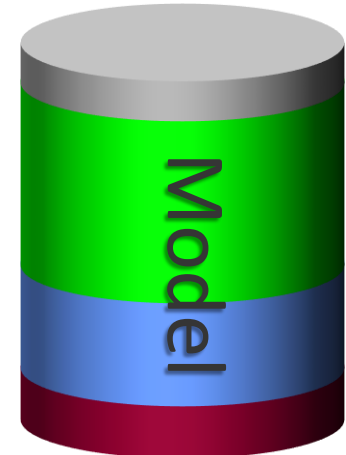
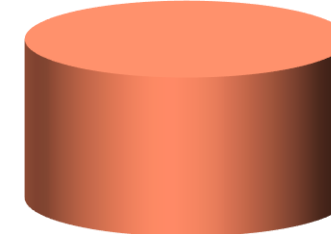


## Classical Approach



- Relevant Information in natural-language based documents (often, table based)
- Verification activities mostly based on textual requirements

## Future Approach?



- Re-distribution of engineering effort?
- Integration of models into overall engineering life cycle?
- Co-existence of natural-language based documents and models?
- How are models considered within ECSS defined deliveries?
- How are models used for V&V activities?



# THANK YOU!

Katarina Jesswein

Contact: [katarina.jesswein@ohv.de](mailto:katarina.jesswein@ohv.de)

Michael Brahm

Contact: [michael.brahm@ohv.de](mailto:michael.brahm@ohv.de)

Co-Authors:

Christoph Gohle (OHV System AG)

Contact: [christoph.gohle@ohv.de](mailto:christoph.gohle@ohv.de)

Bettina Heim (OHV System AG)

Contact: [bettina.heim@ohv.de](mailto:bettina.heim@ohv.de)

Stephan Jahnke (OHV System AG)

Contact: [stephan.jahnke@ohv.de](mailto:stephan.jahnke@ohv.de)

Mohammad Chami (SysDICE GmbH)

Contact: [mohammad.chami@sysdice.com](mailto:mohammad.chami@sysdice.com)