HUMAN FACTORS IN INDUSTRIAL RESEARCH SOFTWARE ENGINEERING

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DLR

Research Software Development at DLR

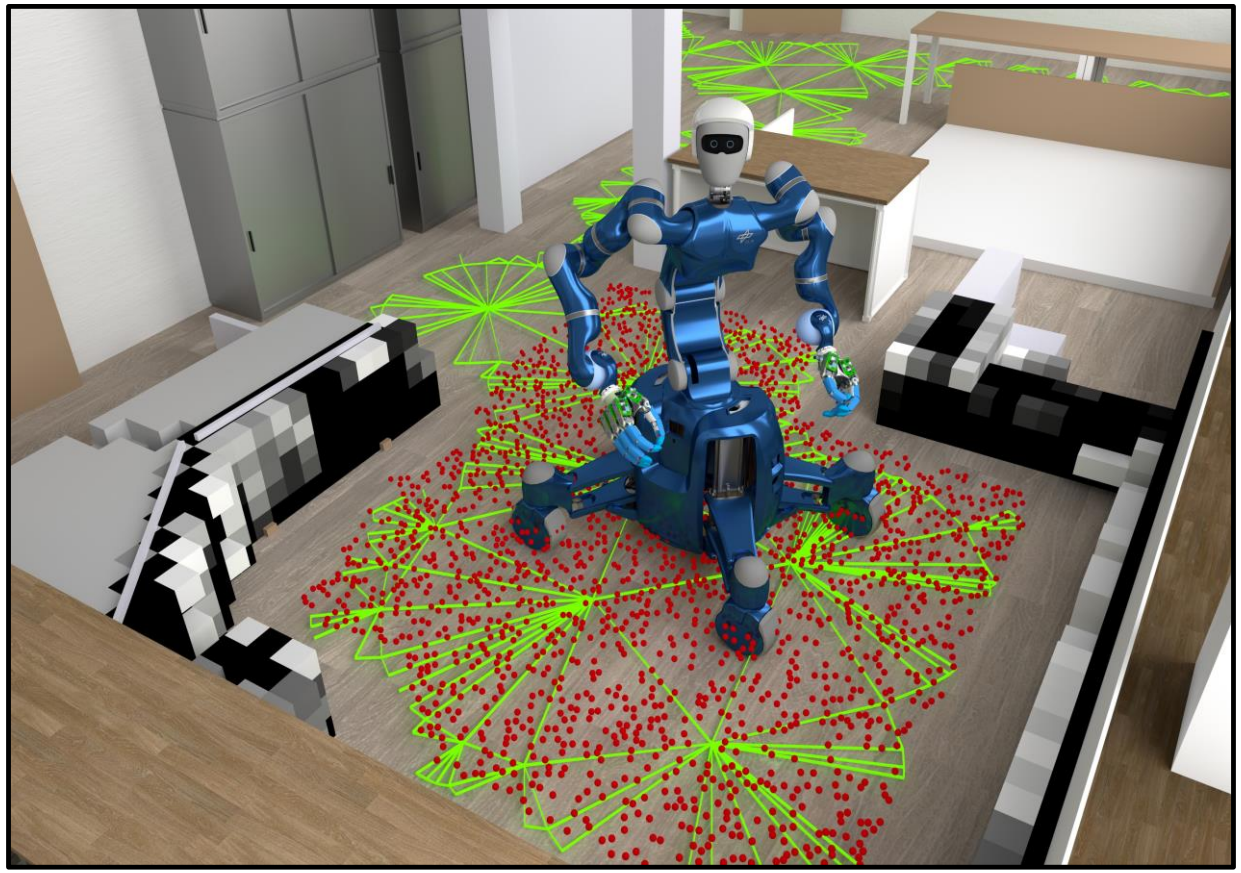
Background

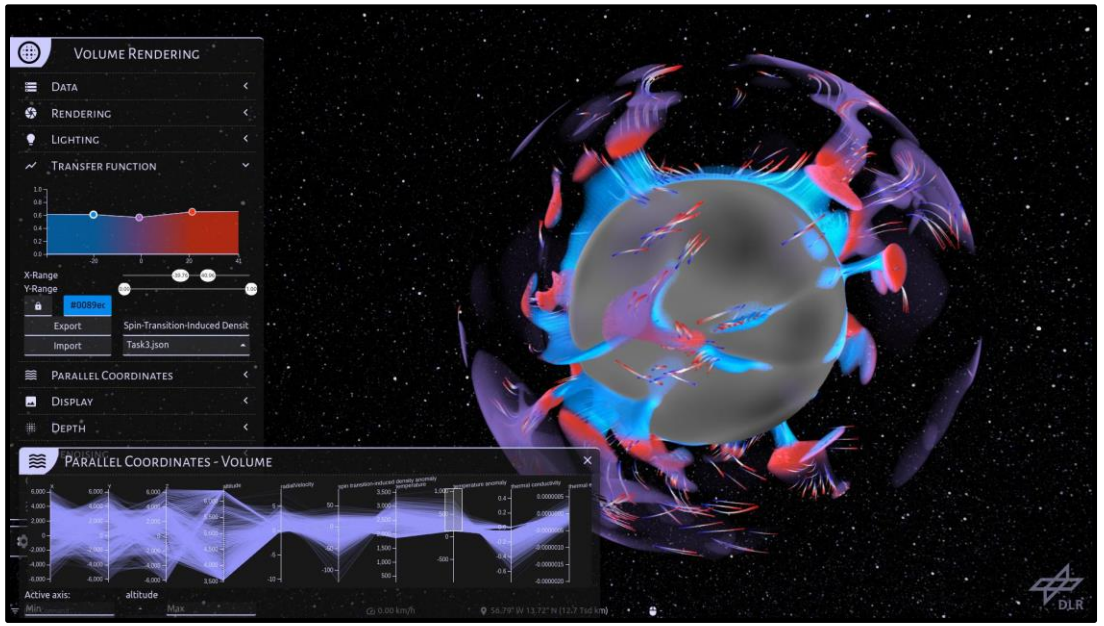
- 10,000+ employees working in 50+ institutes at 30 different locations
- ~20% of DLR employees involved in research software development
- Variety of fields, maturity, and technologies: https://doi.org/10.1145/3387940.3392244

DLR Software Engineering Initiative

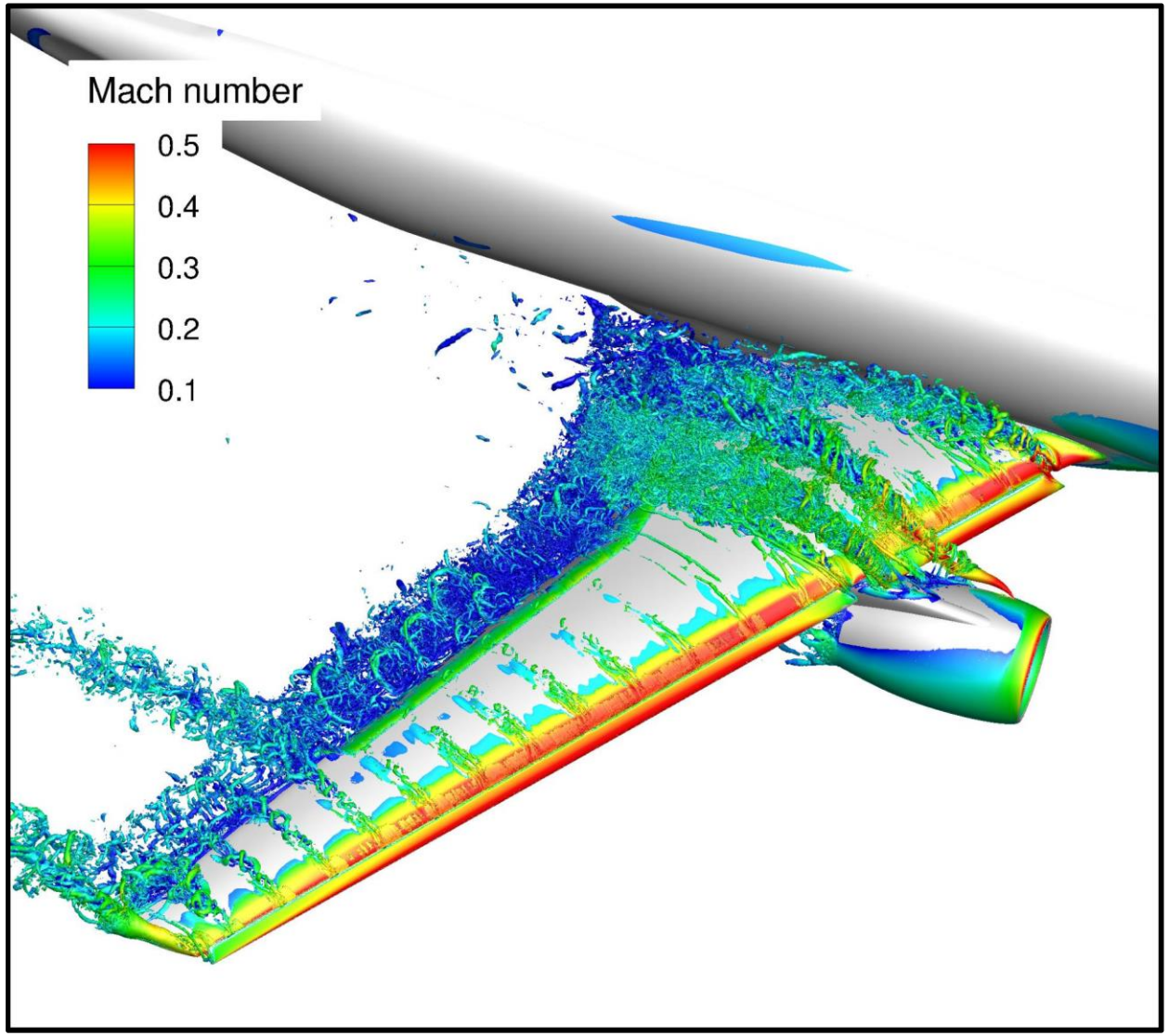
- Activities started in 2005 as part of DLR's quality assurance program
- Since 2017 focus moved more and more on research software development aspects
- Work is driven by the DLR Institute for Software Technology and funded by DLR IT

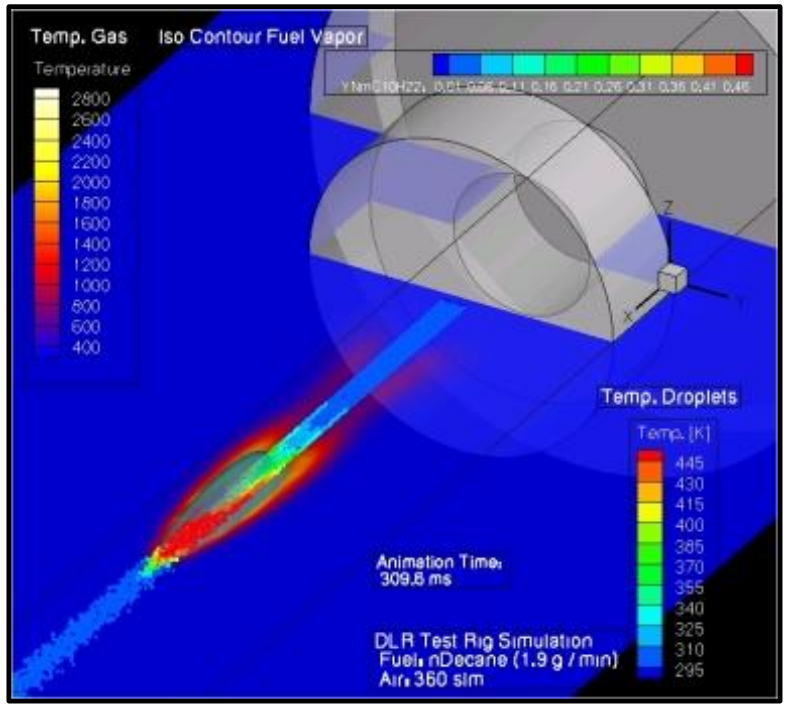
Examples of DLR Software (1/3)



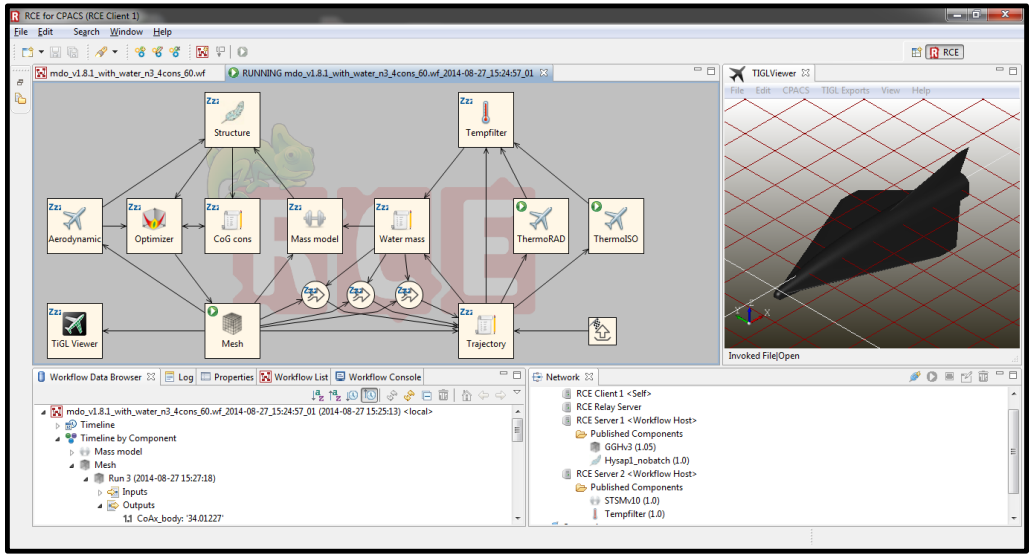


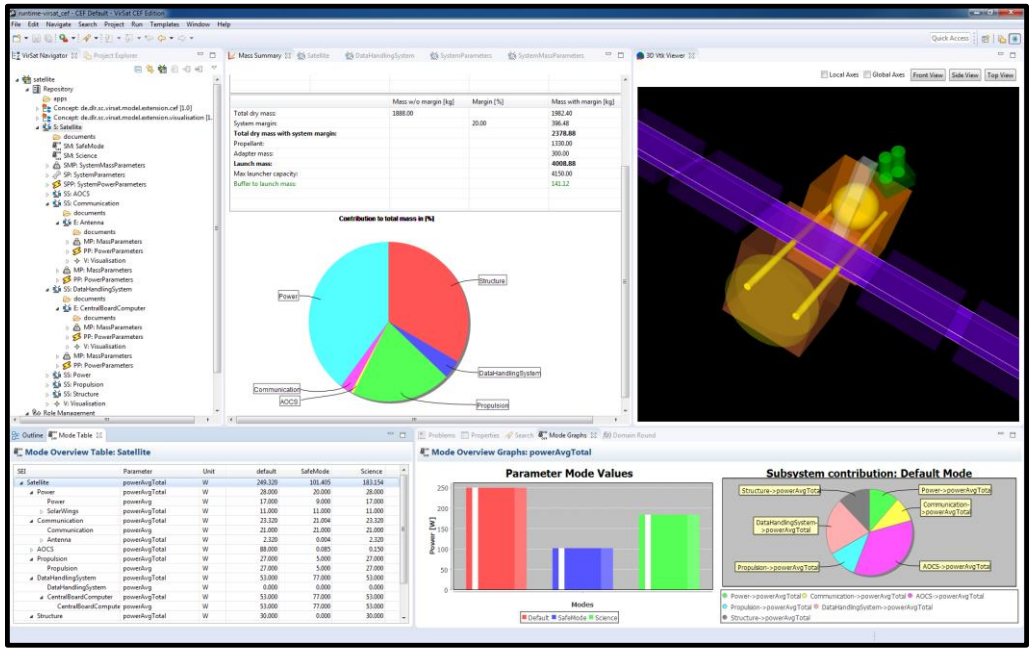
Examples of DLR Software (2/3)

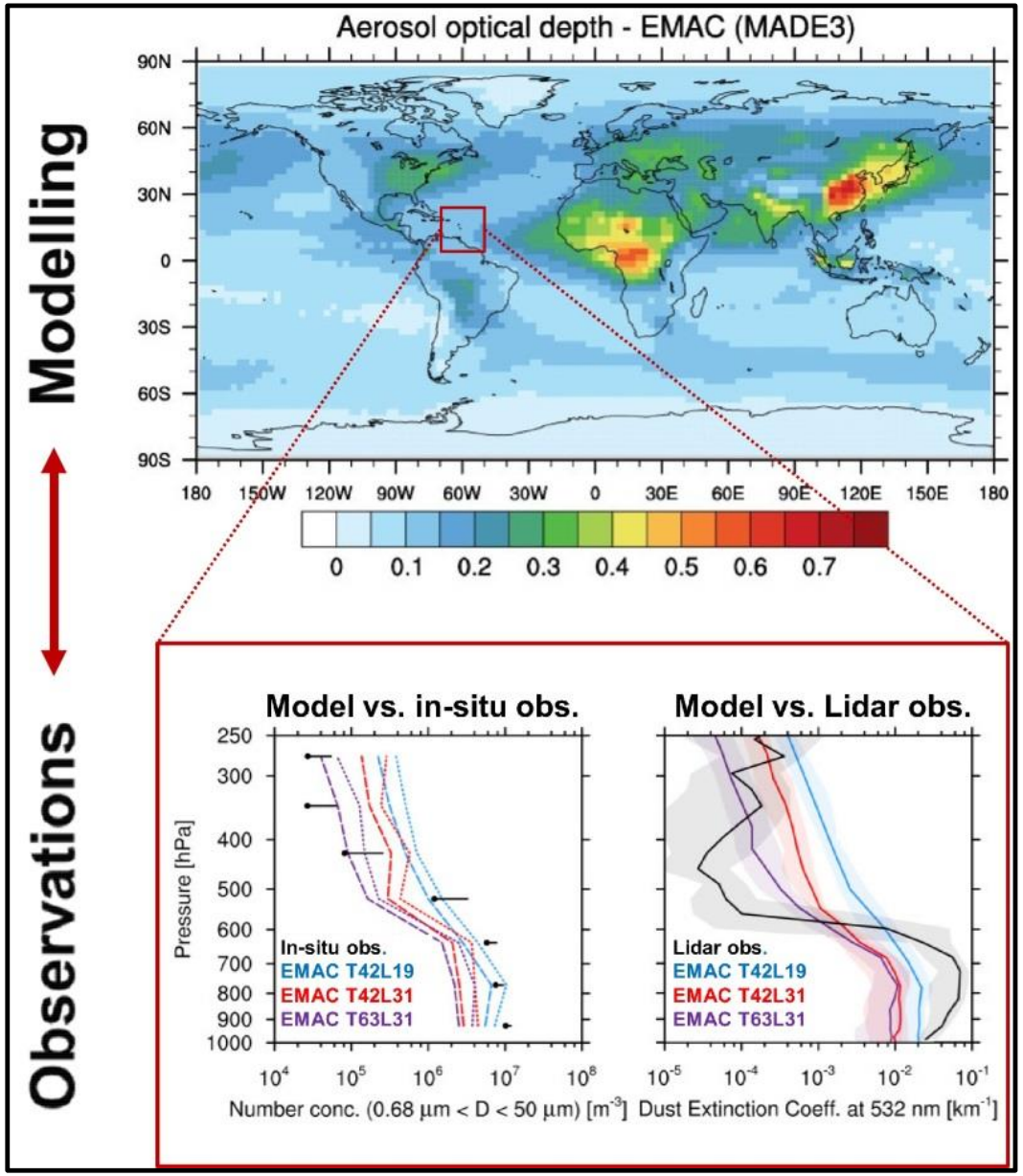




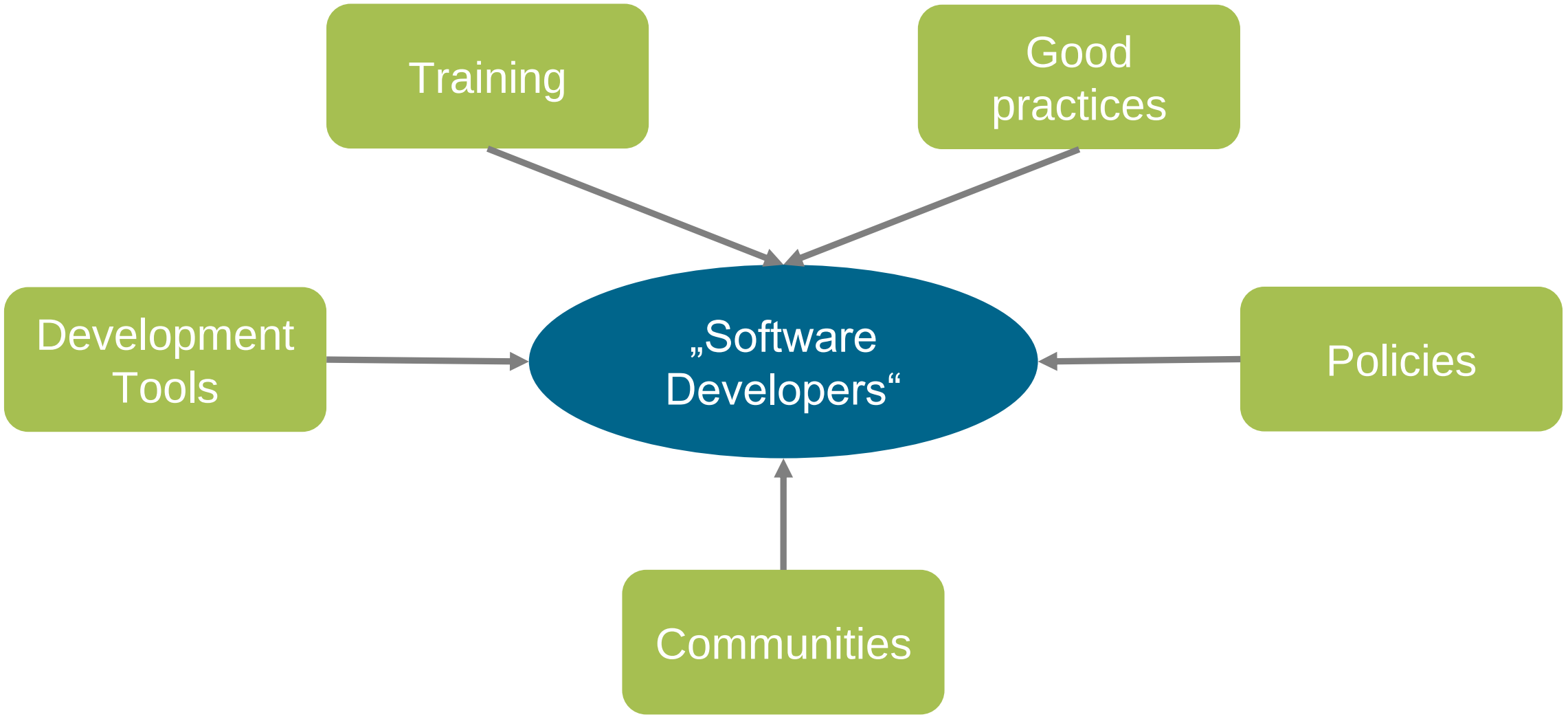
Examples of DLR Software (3/3)







DLR Software Engineering Initiative



DLR Software Engineering Initiative
Examples

DLR SE Guidelines
https://rse.dlr.de/

Change Management

Recommendation	Comment	Status
EÄM.2: The most important information describing how to contribute to development are stored in a central location. *(from application class 1)*	Build steps are missing	todo
EÄM.5: Known bugs, important unresolved tasks and ideas are at least noted in bullet point form and stored centrally. *(from application class 1)*		
EÄM.7: A repository is set up in a version control system. The repository is adequately structured and ideally contains all artifacts for building a usable software version and for testing it. *(from application class 1)*		
EÄM.8: Every change of the repository ideally serves a specific purpose, contains an understandable description and leaves the software in a consistent, working state. *(from application class 1)*		

Git

Issue Tracker

Continuous Integration

Collaboration

...

DLR GitLab Instance

EMPIRICAL RESEARCH INTO RESEARCH SOFTWARE AT DLR

How to support such a heterogenous group to achieve the „right“ level of software quality?

By learning about who they are and what they do:

(PhD) Students	Researchers	Software Engineers
▪ Basic programming skills ▪ Contribute to existing software or develop prototypes ▪ Main focus: Get job / thesis done	▪ Basic programming skills ▪ Contribute to existing software or develop small tools ▪ Main focus: Good research	▪ Advanced level of software development skills ▪ Lead software projects or contribute as consultant ▪ Main focus: Good software

Empirical Research into Research Software at DLR
Surveys

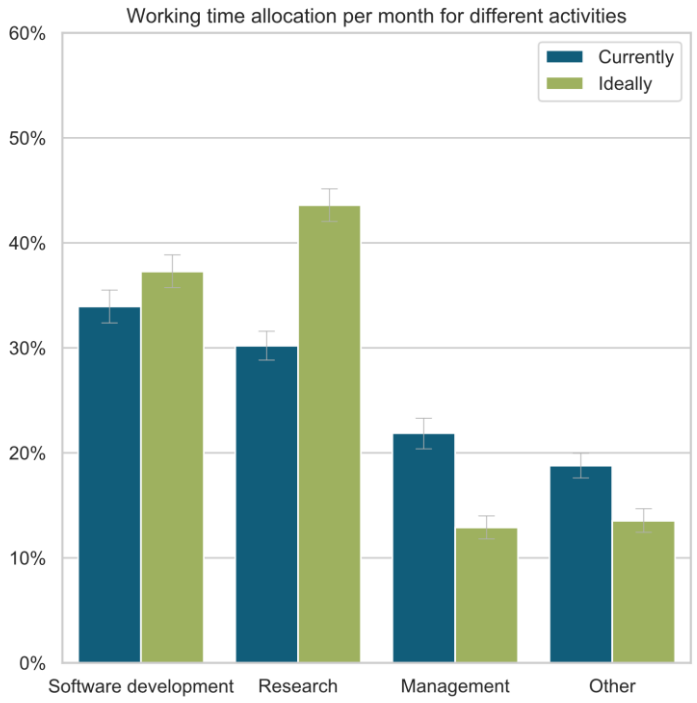
Overview

2018 DLR-wide software survey	2019 DLR sample of Helmholtz-wide software survey	2021 DLR sample of Helmholtz-wide software survey
▪ Sample of n=612	▪ Sample of n=80	▪ Sample of n=79
▪ Age of 25-34 years (44%)	▪ -	▪ -
▪ Master (53%) or PhD (37%)	▪ -	▪ -
▪ Computer Science or Engineering background (62%)	▪ Mostly working in Aeronautics, Space and Transport (73%)	▪ Mostly working in Aeronautics, Space and Transport (88%)
▪ Software development experience M=10.8 SD=8.8	▪ Software development experience M=12.2 SD=9.6	▪ Software development expertise self-assessed as proficient (37%) or advanced (34%)

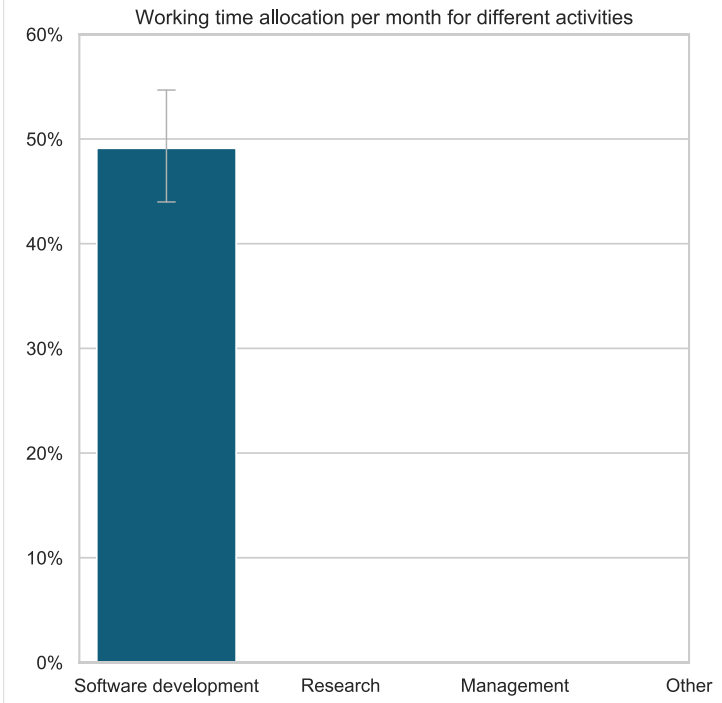
Empirical Research into Research Software at DLR
Surveys

Time Resources

2018
DLR-wide software survey



2019
DLR sample of Helmholtz-wide software survey



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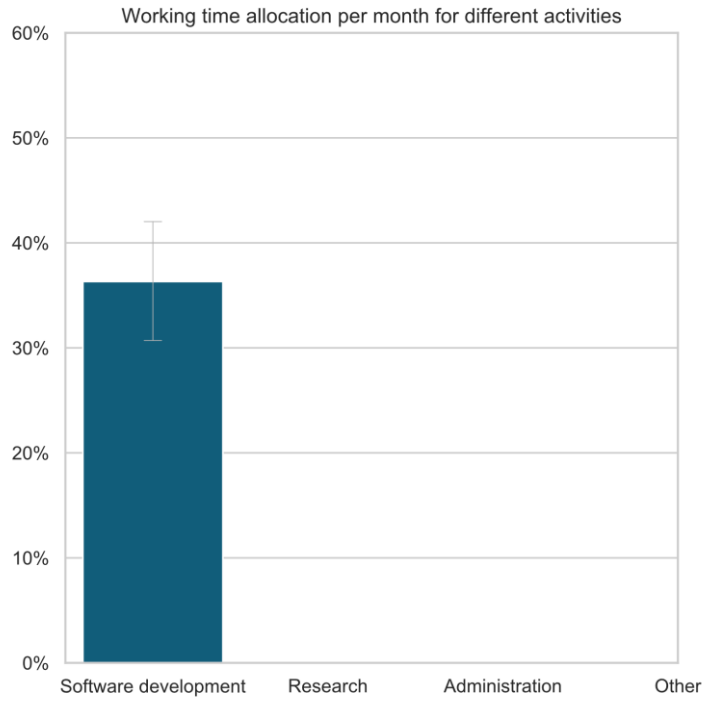
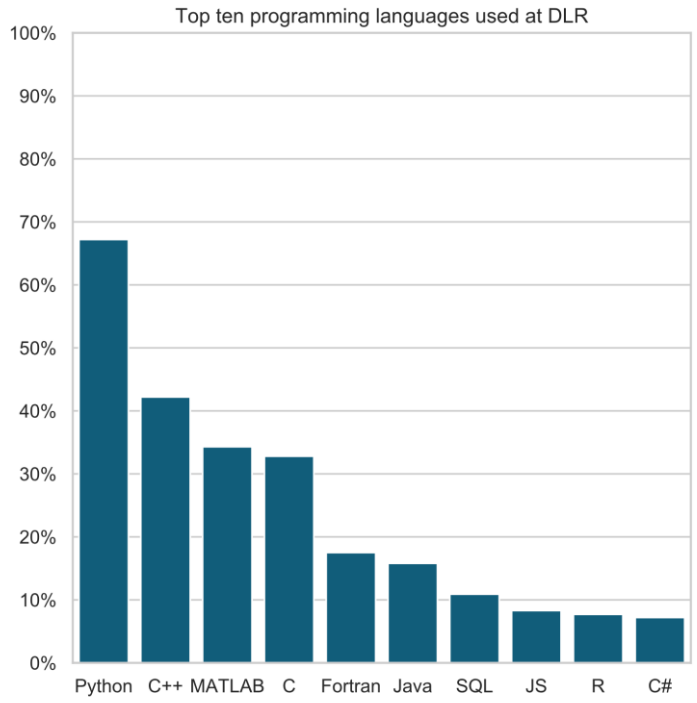


Empirical Research into Research Software at DLR
Surveys

Programming Languages

2018
DLR-wide software survey



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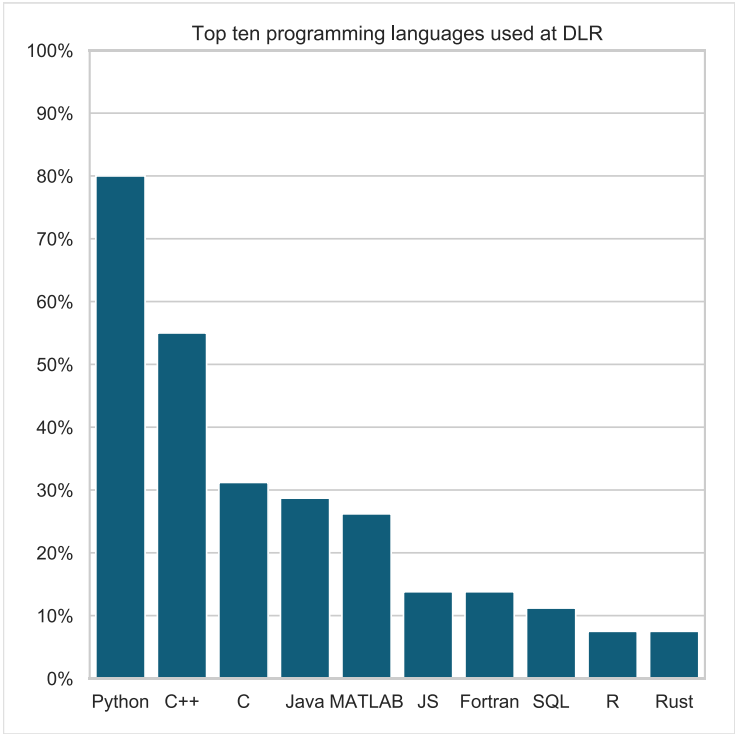

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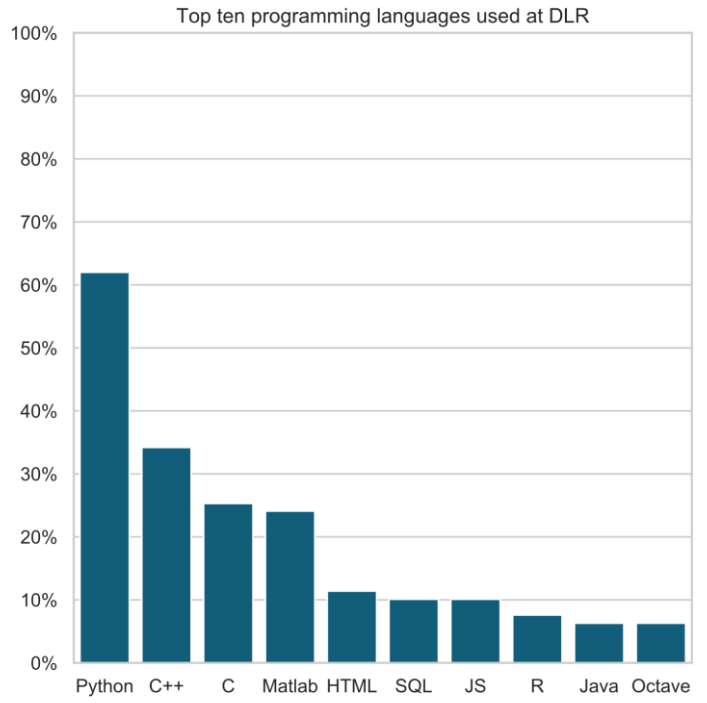
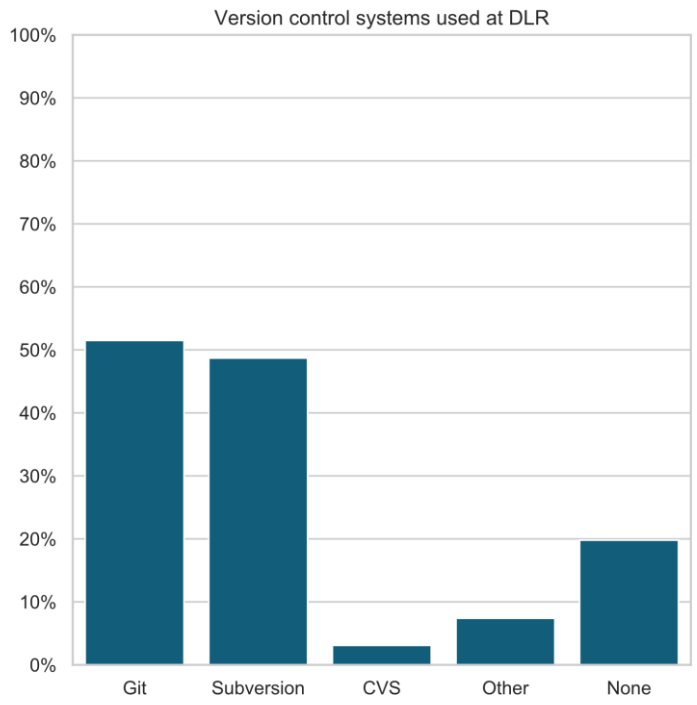


Empirical Research into Research Software at DLR
Surveys

Version Control Systems

2018
DLR-wide software survey



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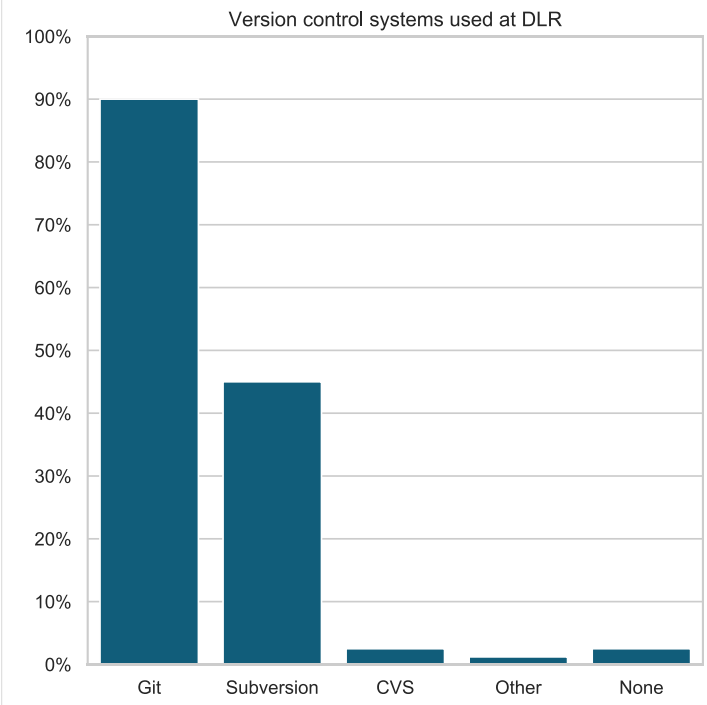

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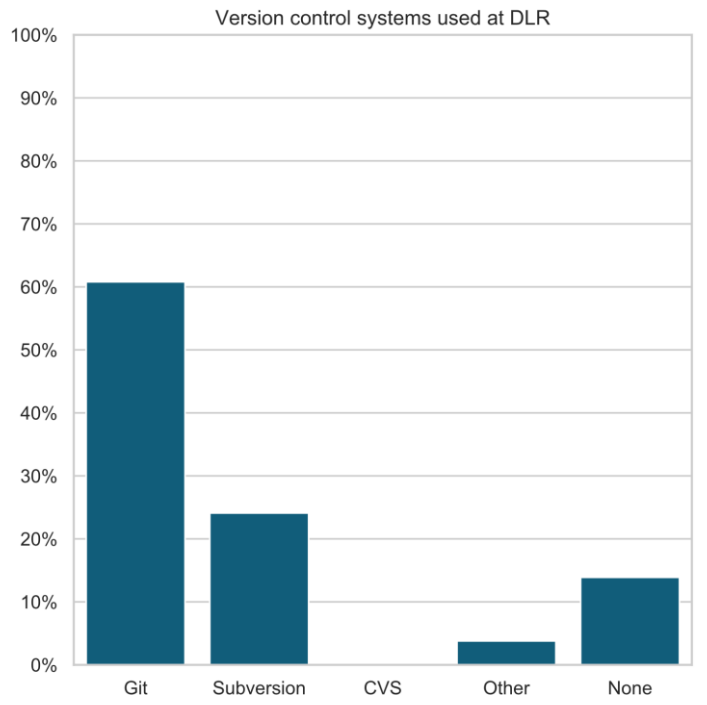
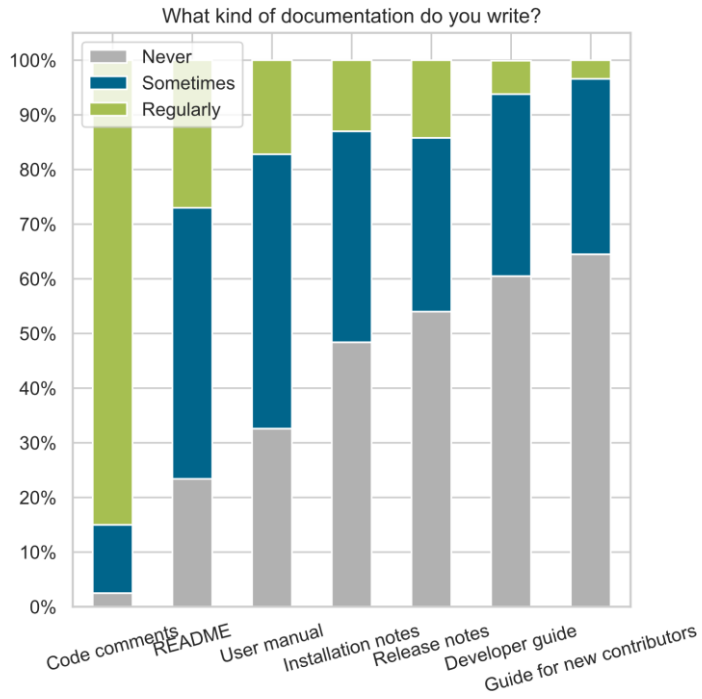


Empirical Research into Research Software at DLR
Surveys

Documentation

2018
DLR-wide software survey



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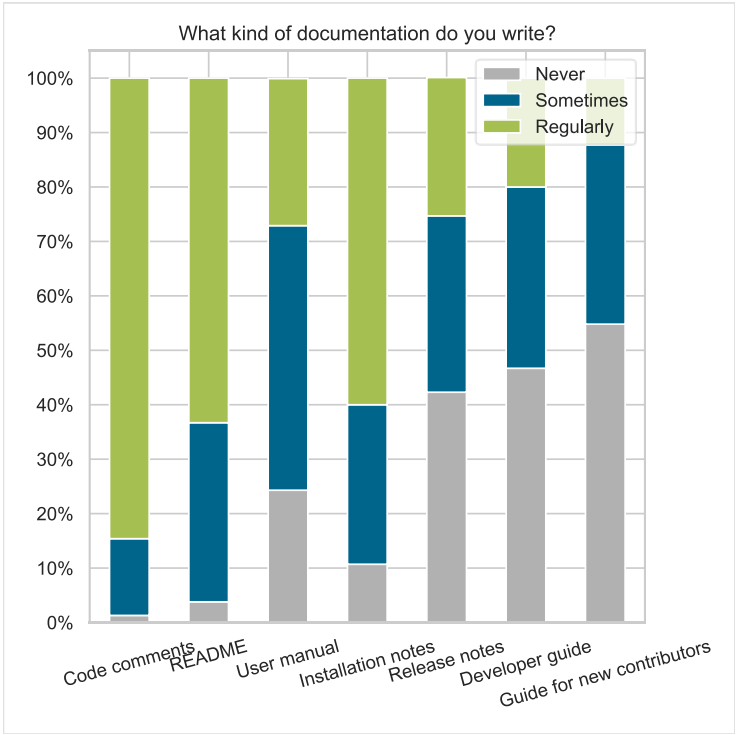


2021
DLR sample of Helmholtz-wide software survey

Empirical Research into Research Software at DLR
Workshops

DLR-internal Training Courses

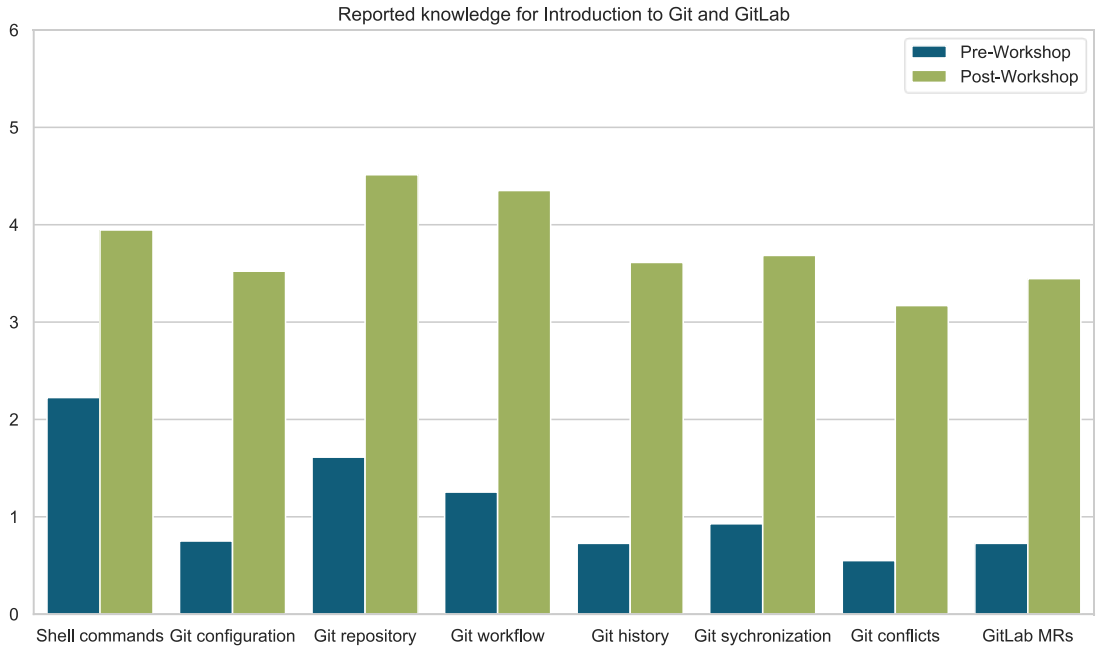
Topic	Approx. # participants per year
Introduction to Git and GitLab	50
Foundations of Research Software Publication	30
GitLab for Software Development in Teams	30

Knowledge Exchange Workshops

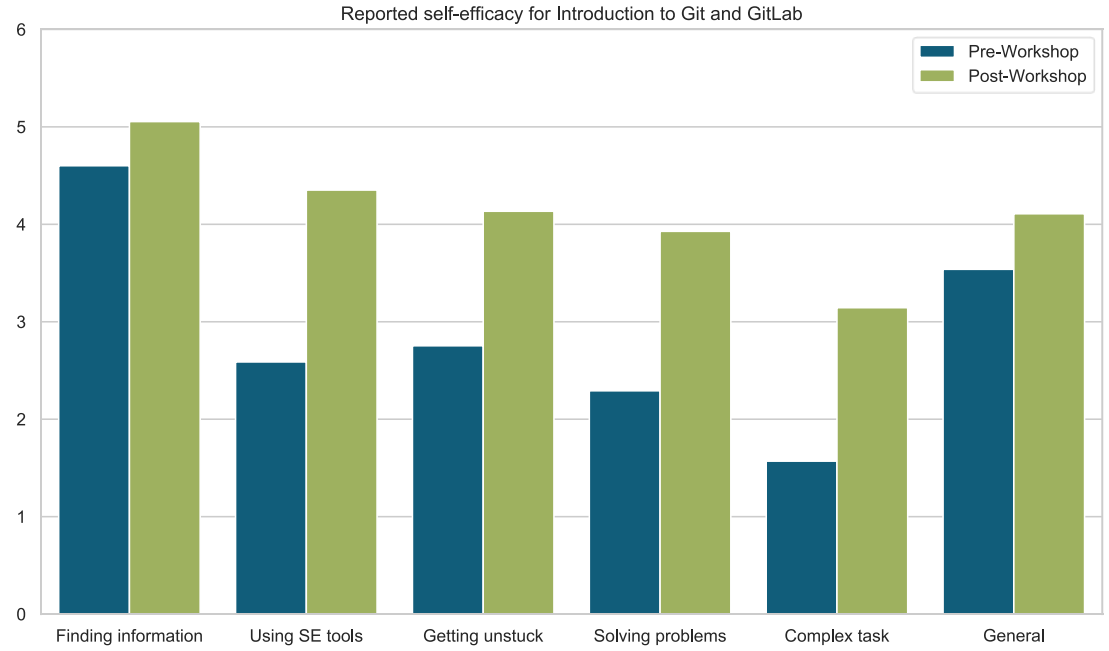
Topic	# Participants	Topic	# Participants
Kick-Off	57	SE for Data Science	55
Tools and Processes	56	Software Architecture	70
Open and Inner Source	53	Distributed Teams	71
Software Architecture	52	Inner Source and Legacy Code	65
Embedded Systems	47	SE meets Research Software Development	?

Empirical Research into Research Software at DLR
Workshop Pre-Post-Surveys

Knowledge



Self-Efficacy

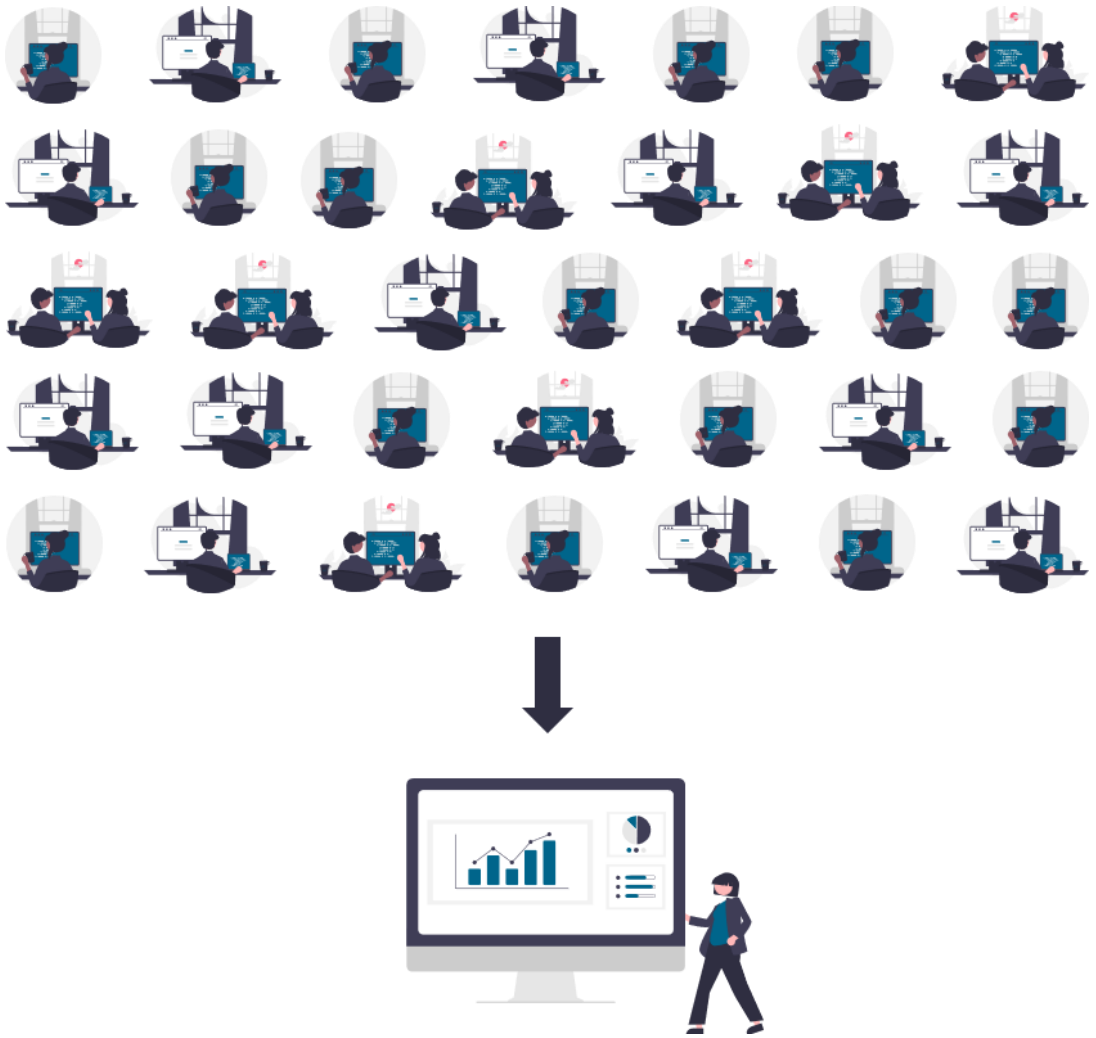


A STEP FORWARD: HUMAN SUBJECT POOL

Human Subject Pool

Motivation

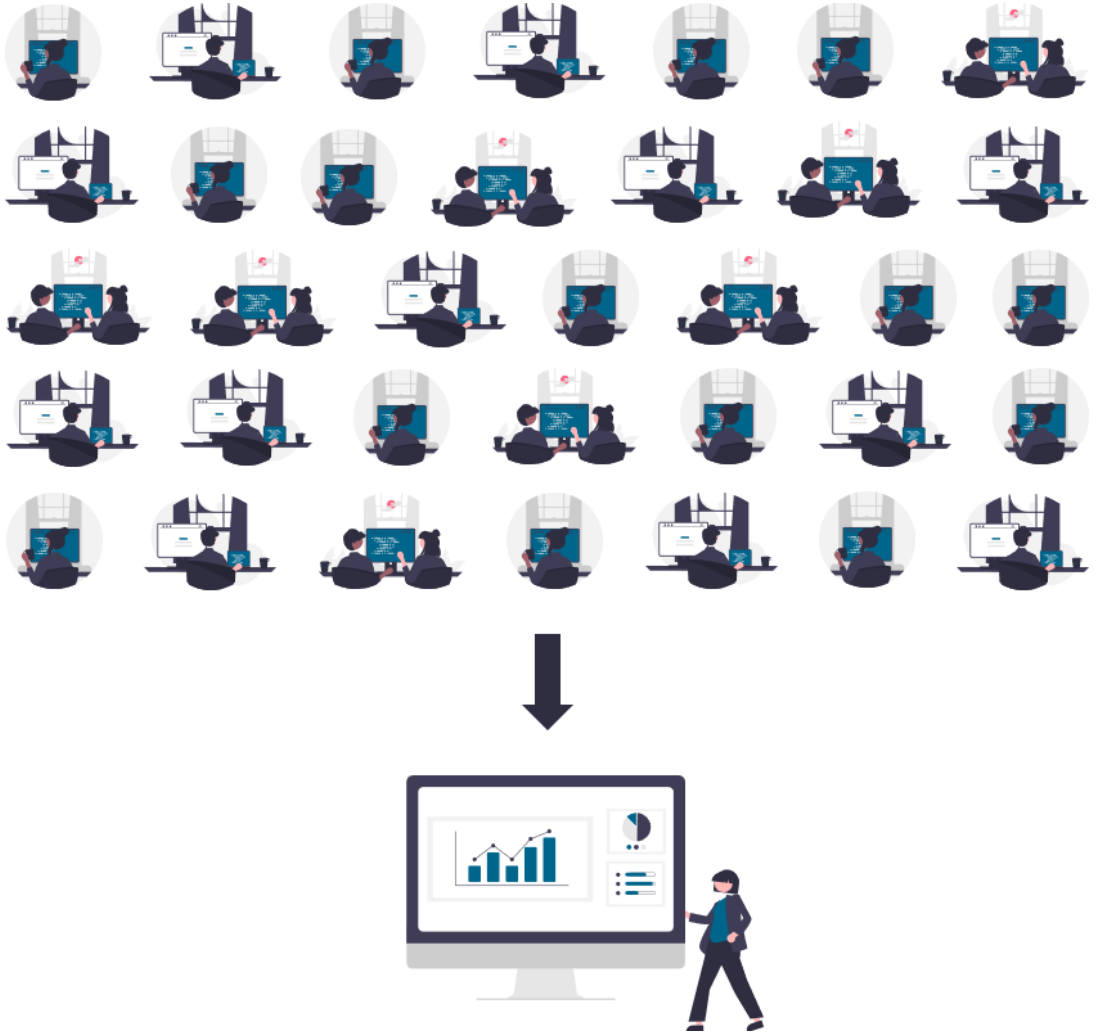
- Streamline study organization
- Facilitate re-use of previous surveys to introduce more consistency
- Pre-screen for predefined criteria to recruit only relevant subjects
- Simplify sampling for cross-sectional studies
- Realize longitudinal studies to identify trends while controlling for cohort effects
- Realize within-subject designs



Human Subject Pool

Mission

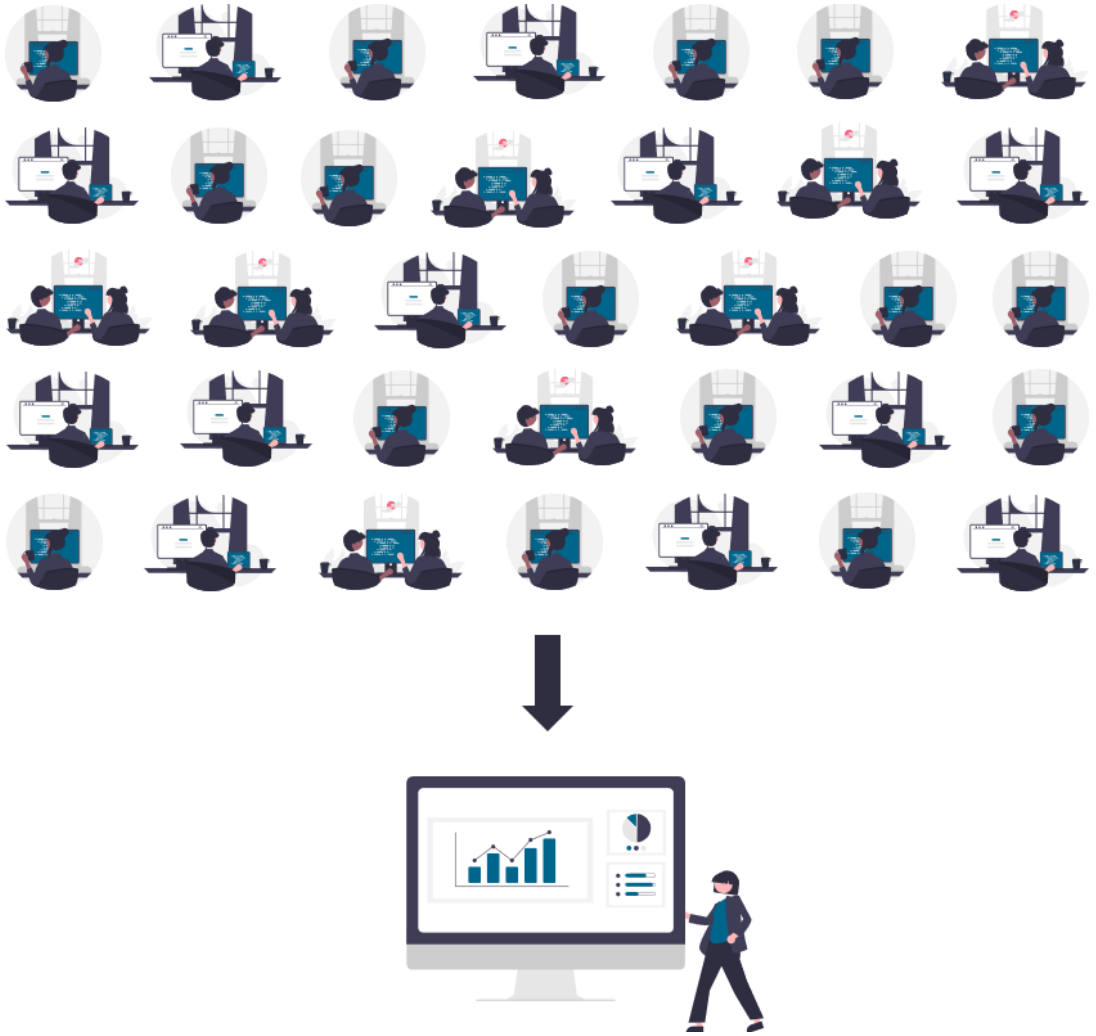
- Establish initial pool of 30+ subjects and test subject pool system within DLR SE network
- Expand subject pool to 500 subjects and conduct large-scale SE survey
- Expand subject pool beyond DLR including other Helmholtz centers and additional German research organizations to get a better picture of the German RSE community



Human Subject Pool

Challenges

- How to motivate initial registration?
  - Establish a „survey culture“
  - Make relevance of previous results more transparent
- How to motivate participation?
  - PhD students: credit
  - Researchers and software engineers: monetary compensation
- How to handle no-shows?
- How to handle high fluctuation?



SUMMARY

Summary

- Software of different maturity levels is developed and maintained by researchers with varying software engineering backgrounds at DLR.
- DLR`s software engineering initiative aims to provide the overall environment to support “software developers” at DLR.
- DLR regularly conducts surveys to better understand the current practice and needs of the individual groups and to optimize our support offerings.
- However, previous surveys employed a cross-sectional design and focused on different aspects.
- For future studies, we aim to build a human subject pool to facilitate sampling and to investigate long-term effects.

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Thank you!

What are your Questions?

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