Growing preCICE from an as-is coupling library to a sustainable, batteries-included ecosystem

ECP Webinar series:
Best Practices for HPC Software Developers

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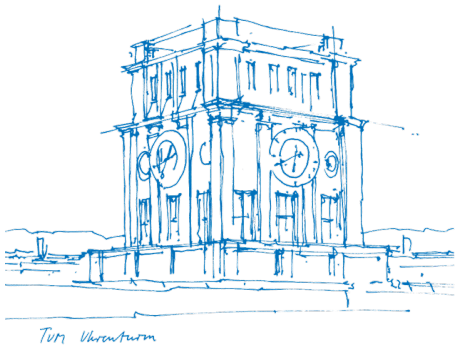
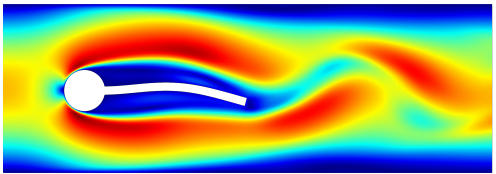
Technical University of Munich

July 6, 2022



Motivation: Partitioned multi-physics simulations



Fluid-Structure Interaction:
Turek-Hron FSI3 benchmark

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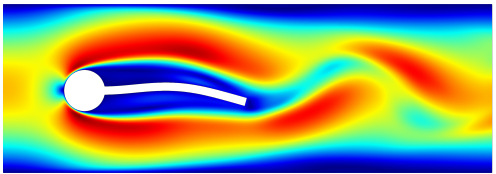

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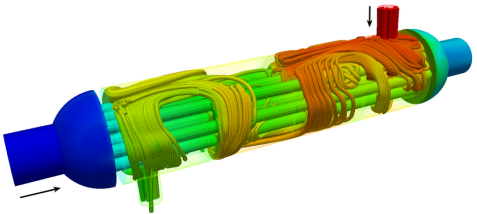
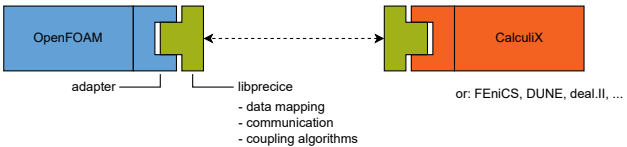


Conjugate Heat Transfer:
heat exchanger

preCICE in a nutshell



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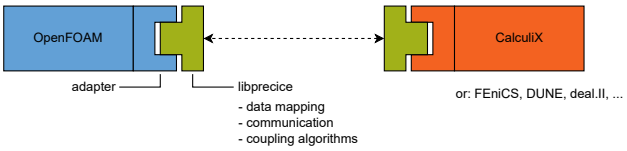


```
while (t < t_end){
  solve(dt);
  precice.write_data(force);
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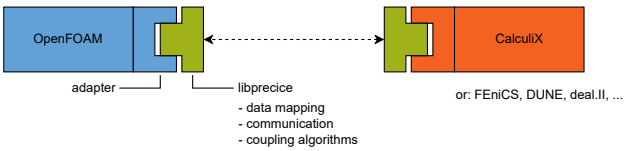


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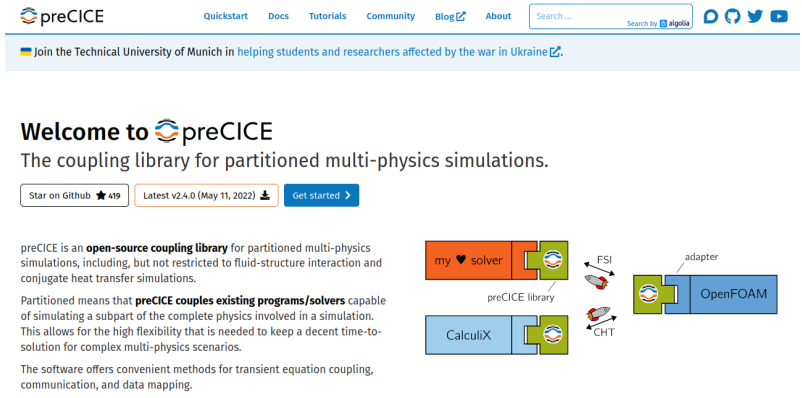
Adapters and examples for: OpenFOAM, SU2, CalculiX, deal.II, FEniCS, DUNE, Nutils, ...

API in C++, C, Fortran, Python, Matlab, Julia

Walking around the website (1)

- Available adapters
- Tutorials
- Quickstart

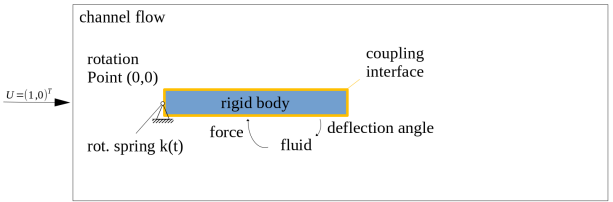


Live demo

Quickstart tutorial:
precice.org/quickstart.html

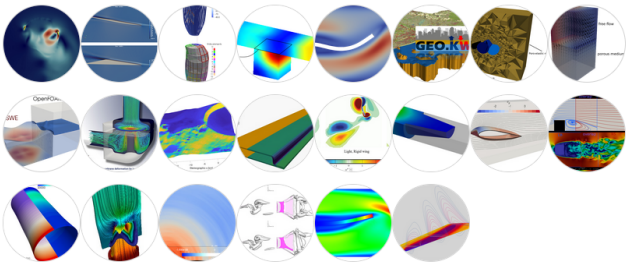
Running on the preCICE demo VM:
precice.org/installation-vm.html

Homework: Run it yourself! :-)



Walking around the website (2)

- Couple your code
- User stories
- Who uses preCICE



Achievements unlocked: Usability & Reachability

You don't need to talk to us to successfully use preCICE,

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You don't need to talk to us to successfully use preCICE,
but if you want, you can reach us very easily.

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but if you want, you can reach us very easily.

"Afer the amount of support I received from this community, I am switching to opensource for every one of my needs."

(@nithinadidela on the preCICE forum)

But why all this effort?

We are not the target users of preCICE:
we research and develop methods and software, not applications.

Lessons learned

Lessons learned: Technical

1. Library vs framework
2. Separation of concerns
3. Few, common dependencies
4. Packages for common platforms
5. Standard practices (e.g., xSDK[1], OpenSSF Best Practices[2], code quality checkers)

Project Status

release v2.4.0 | doi 10.18419/darus-2613 | Build and Test passing | system tests check

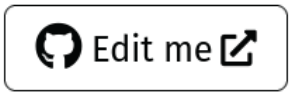
Project Quality

openssf best practices passing | codefactor A | lgtm:C++ A+ | codecov 89%

[1] https://xsdk.info/
[2] https://bestpractices.coreinfrastructure.org/

Lessons learned: Documentation

1. Content from multiple sources, rendered at one place
   - website + a wiki for each repository + dev docs $\rightarrow$ website
   - content next to code
   - content available offline
2. Very easy to contribute (“edit me” button + review)



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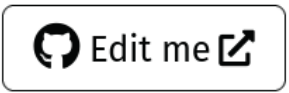

Implementation: GitHub Pages (Jekyll) + Bootstrap

Extra features: search (Algolia), PDF export (Prince), privacy-respecting analytics (Plausible)

Lessons learned: Documentation (2)

Q&A strategy: add to the documentation, send link as answer

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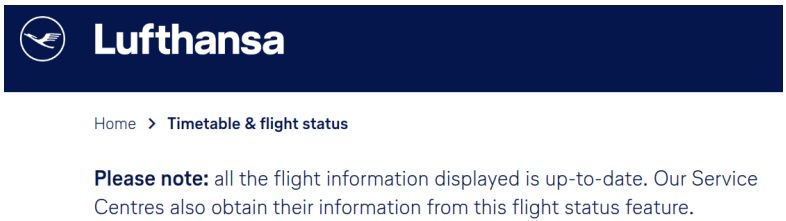
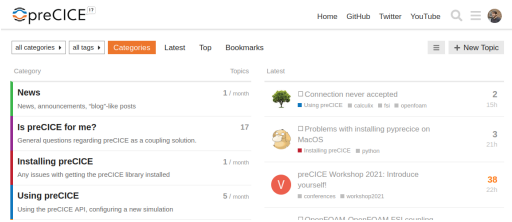


Lessons learned: Communication

1. Mailing list + chatroom → Discourse forum
   - Threaded, great search, tags, categories, answers, ...
   - Also used as blog, FAQ, conferences
2. preCICE Workshops (+ feedback, training)
3. Some outreach is essential.



Lessons learned: Release strategy

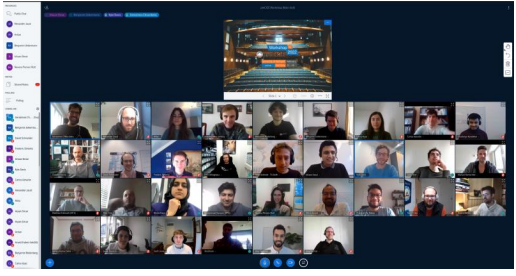
1. Major (breaking) releases not too often (min. 2-3 years)
2. Feature releases often, but not too often (6 months)
3. Downstream component releases at anytime
4. Ecosystem distribution (1-2/year)

Still learning: Publication strategy

1. Reference article
   - 1.1 Needs updates (features, results, authors)
   - 1.2 Also reference articles for adapters
2. Feature-specific articles
3. Citable ecosystem distribution

Workshops

Workshop
#4
2023
preCICE
Technical University of Munich
Germany
February
13 - 16



Challenge: Sustainable funding

1. Research-driven, niche topic: academic funding important
2. Research proposals together with users
3. Workshops
4. More support and collaboration requests than we can handle

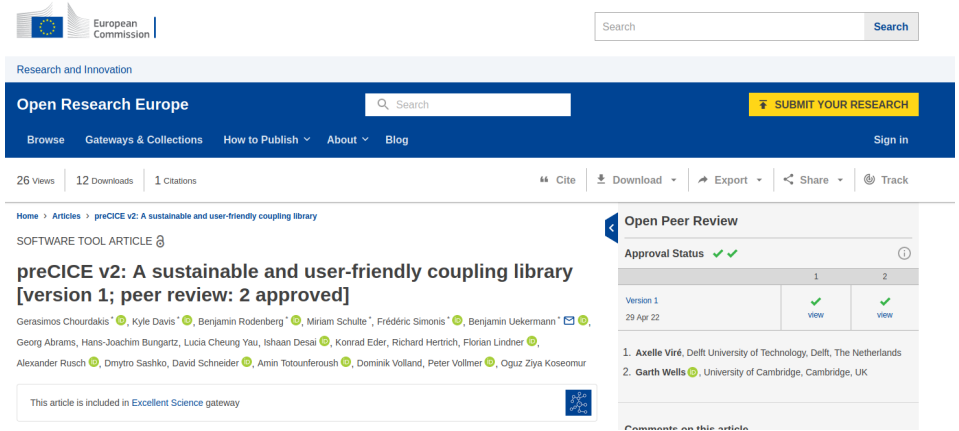
Solution: Support program

Not discussed (feel free to ask)

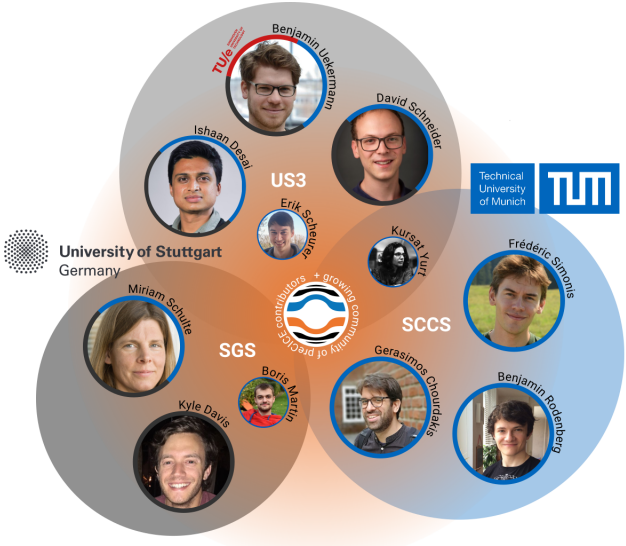
- Features, numerics, performance
- Testing and CI
  - BSSW Blog post: “Overcoming Complexity in Testing Multiphysics Coupling Software”
  - System tests
- Collaboration & project management
- Outreach
- ...

(enough topics for future talks)

Key reference (fresh!)



People


Benjamin Uekermann
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Ishaan Desai
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Germany
Technical University of Munich
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growing community of preCICE contributors
SCCS
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Boris Martin
Benjamin Rodenberg
Kyle Davis

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DFG

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- EXC 2075 SimTech

EuroTech Universities

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SPPEXA

KONWIHR

See also

Talks at the same webinar series with similar interests:

OpenFOAM Tomislav Maric, July 2021 and March 2022:
“A Workflow for Increasing the Quality of Scientific Software”
“Software Design Patterns in Research Software with Examples from OpenFOAM”

deal.II Wolfgang Bangerth, September 2021:
“What I Learned from 20 Years of Leading Open Source Projects”

xSDK Ulrike Meier Yang & Piotr Luszczek, December 2019:
“Building Community through xSDK Software Policies”

E4S Lois Curfman McInnes, December 2021:
“Scientific software ecosystems and communities: Why we need them and how each of us can help them thrive”

Summary

Main message: always think of the user, it may be highly beneficial (in the long run).

Discussed:

- Coupling with preCICE
- Technical decisions
- Documentation
- Communication
- Release & publication strategy
- Sustainable funding

Slides & feedback: go.tum.de/266671

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(Note: looking for a research stay abroad in 2023)