15th OpenFOAM Workshop - June 24, 2020 - Training III-E

Multiphysics Modeling with the preCICE Coupling Library

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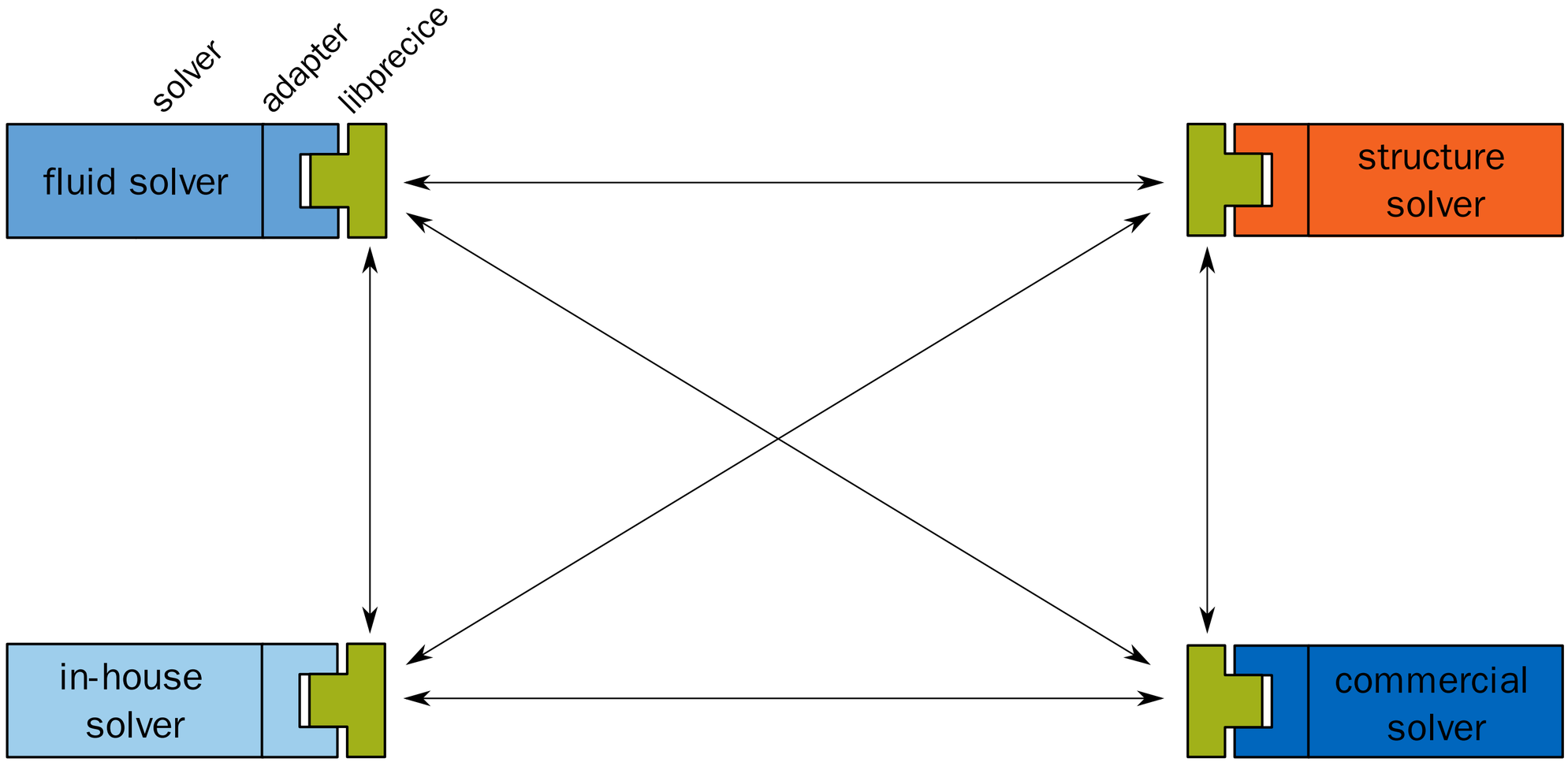
TU/e

Organizational notes

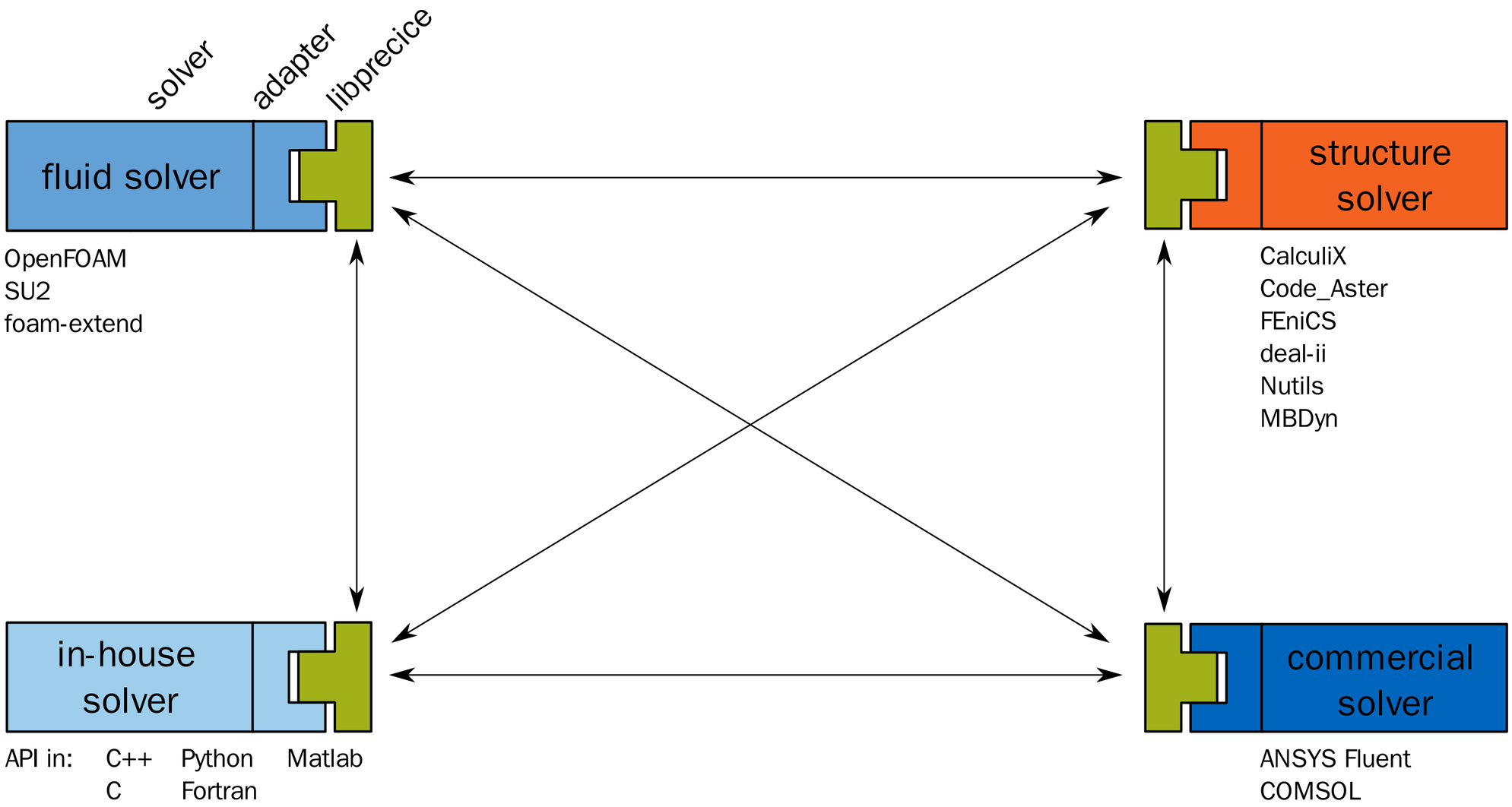
1. You are not expected to try things live.
2. Ask questions in the chat, moderated by Benjamin.
3. Find these slides on GitHub:
   https://github.com/MakisH/ofw15-slides
4. Everything presented here is free software. preCICE and all the adapters are developed publicly on
   https://github.com/precice/

The big picture

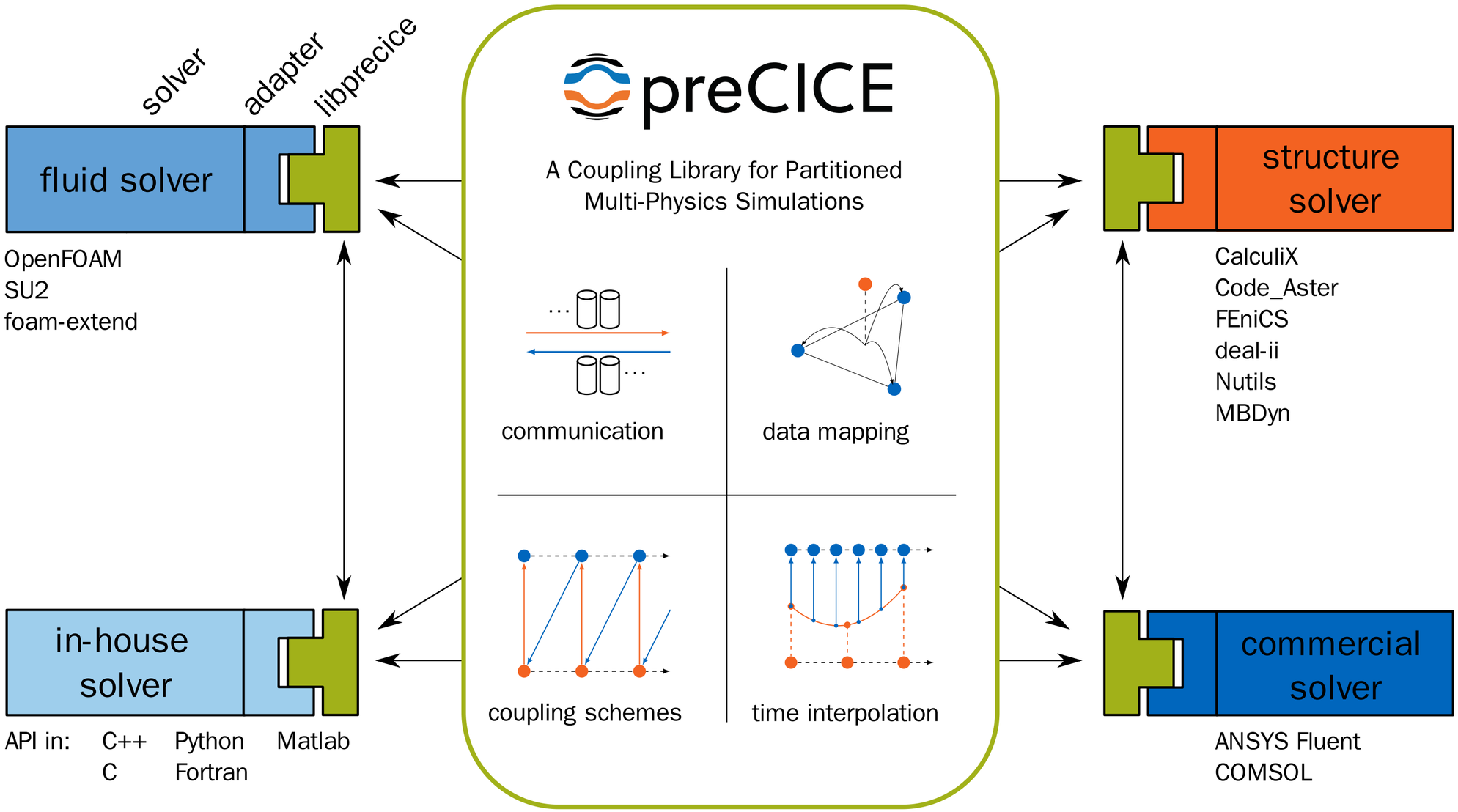
The big picture



The big picture



The big picture



This tutorial

- Level 1: Couple two simple Python solvers
- Level 2: Couple OpenFOAM with OpenFOAM
- Level 3: Couple OpenFOAM with an external solver

Level 1: Call the preCICE API in the code
Levels 2 & 3: Directly use off-the-shelf adapters

Level 1: Coupling two simple solvers

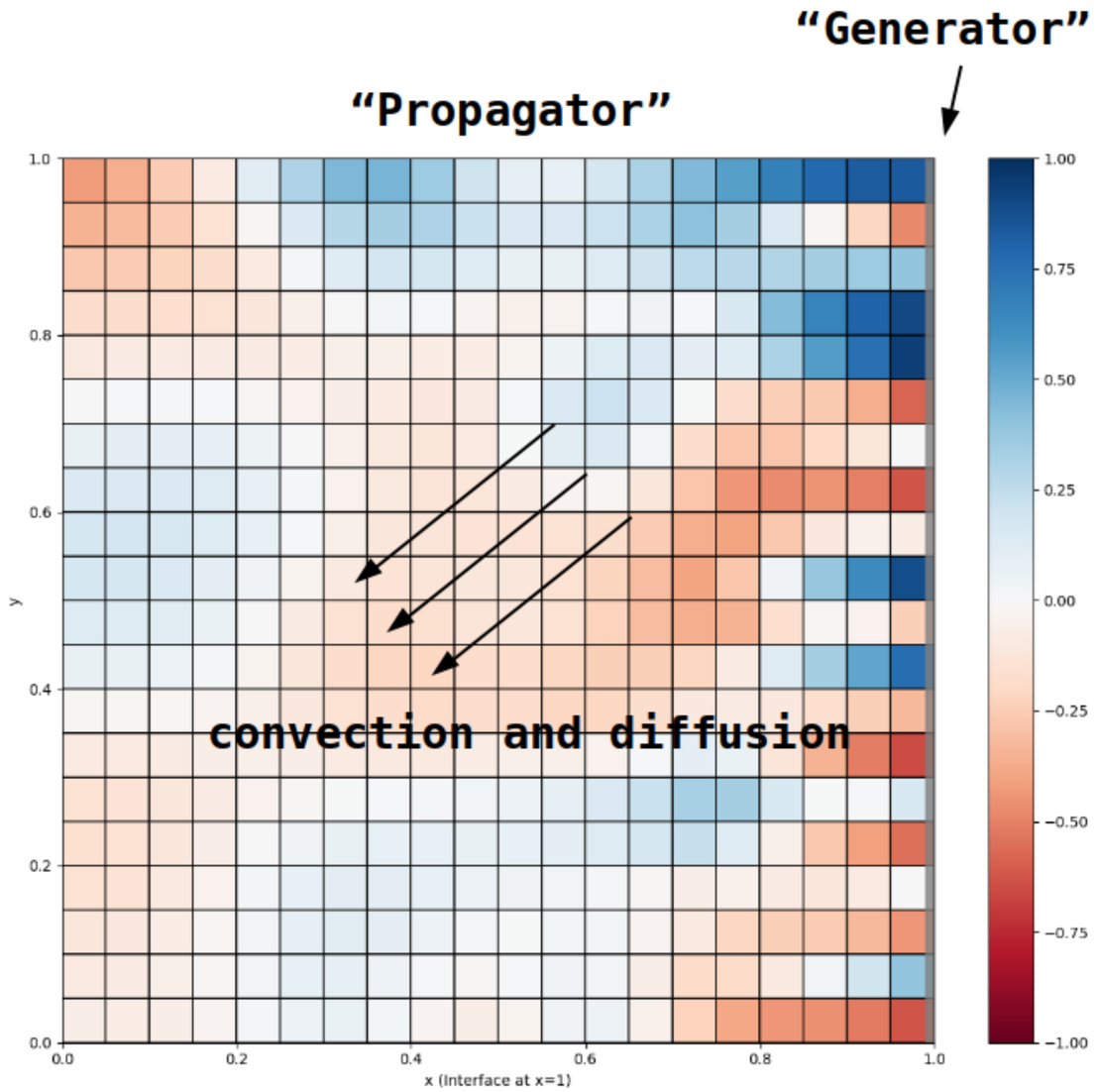
Dependencies

- preCICE v2 (e.g. packages for Ubuntu)
- Python 3
- Python packages `numpy`, `matplotlib`
- preCICE Python bindings:

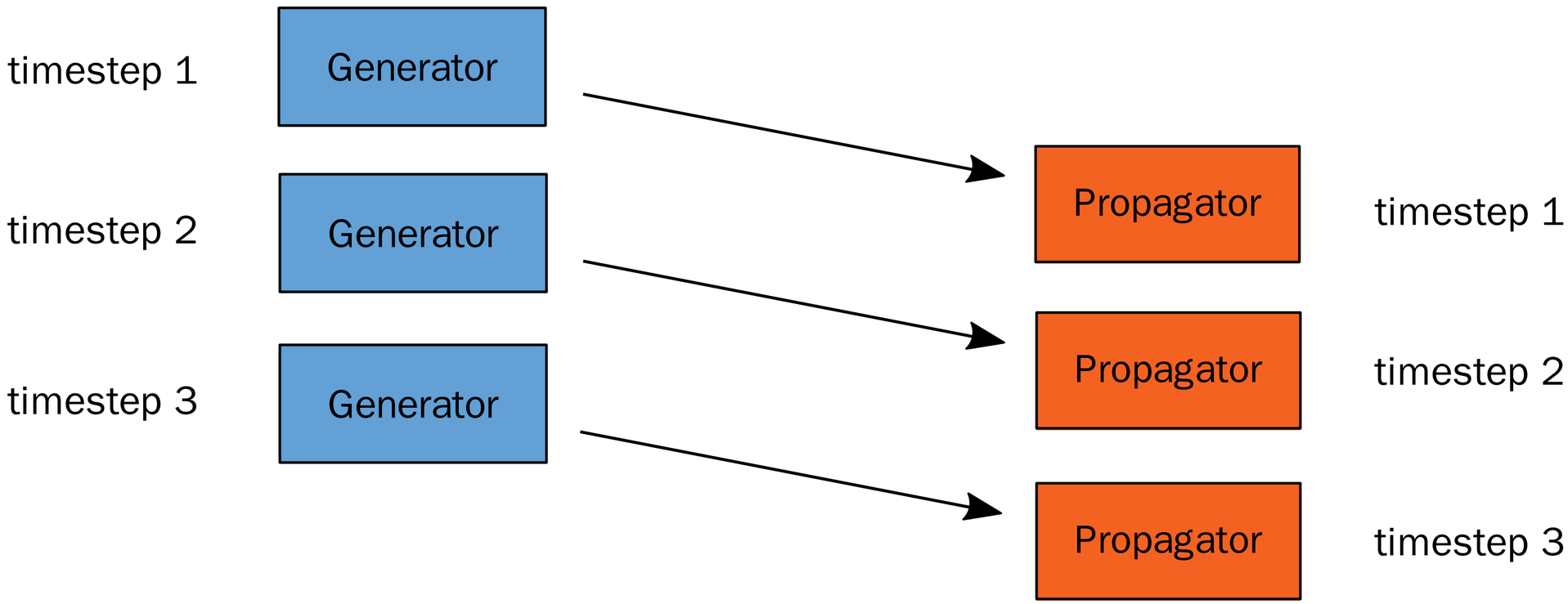
```
pip3 install --upgrade pip
pip3 install --user pyprecice
```

"Generator" and "Propagator"

- `generator.py`: generates random data in a 1D domain
- `propagator.py`: propagates boundary data over a 2D domain



Unidirectional coupling



generator.py

```
import numpy

# generate mesh
n = 20
y = numpy.linspace(0, 1, n + 1)

dt = 0.01
t = 0

while True:
  print("Generating data")
  u = 1 - 2 * numpy.random.rand(n)

  t = t + dt
  if(t > 0.1):
    break
```

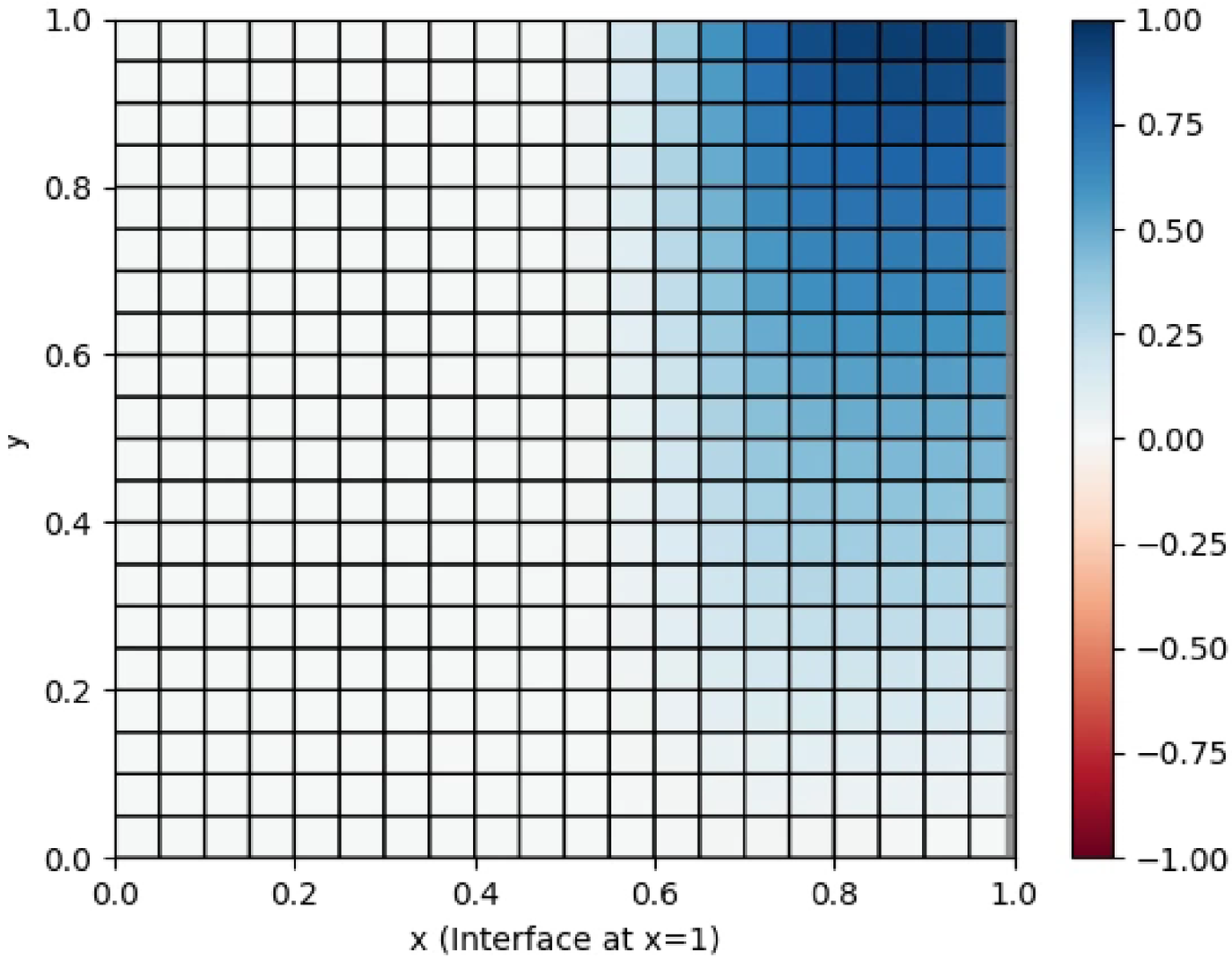
Find these files in github.com/MakisH/ofw15-slides/training/generator-propagator.

propagator.py

```
# generate mesh
n = 20
x = numpy.linspace(0, 1, n+1)
y = numpy.linspace(0, 1, n+1)

# initial data, associated to cell centers
u = numpy.zeros([n, n])

dt = 0.01
t = 0

# boundary condition for u (arbitrary)
u[:,-1] = y[:-1]

while True:

  print("Propagating data")
```

```
(base) ~/uncoupled$ python3 generator.py
Generating data
Generating data
Generating data
Generating data
Generating data
Generating data
Generating data
Generating data
Generating data
Generating data
Generating data
(base) ~/uncoupled$ python3 propagator.py
```

Uncoupled simulation



Import preCICE

```python
import numpy


# generate mesh
n = 20
y = numpy.linspace(0, 1, n + 1)

dt = 0.01
t = 0

while True:
  print("Generating data")
  u = 1 - 2 * numpy.random.rand(n)

  t = t + dt
  if(t > 0.1):
    break
```

Import preCICE

```python
import numpy
import precice

# generate mesh
n = 20
y = numpy.linspace(0, 1, n + 1)

dt = 0.01
t = 0

while True:
  print("Generating data")
  u = 1 - 2 * numpy.random.rand(n)

  t = t + dt
  if(t > 0.1):
    break
```

Configure preCICE

```python
import numpy
import precice

# generate mesh
n = 20
y = numpy.linspace(0, 1, n + 1)

# preCICE setup
participant_name      = "Generator"
config_file_name      = "precice-config.xml"
solver_process_index = 0
solver_process_size  = 1
interface =
    precice.Interface(
                        participant_name,
                        config_file_name,
                        solver_process_index,
```

Configure preCICE

```
 5 n = 20
 6 y = numpy.linspace(0, 1, n + 1)
 7
 8 # preCICE setup
 9 participant_name      = "Generator"
10 config_file_name      = "precice-config.xml"
11 solver_process_index = 0
12 solver_process_size  = 1
13 interface =
14     precice.Interface(
15                         participant_name,
16                         config_file_name,
17                         solver_process_index,
18                         solver_process_size
19                       )
20
21 dt = 0.01
22 t = 0
```

Define the coupling mesh

```
 5 n = 20
 6 y = numpy.linspace(0, 1, n + 1)
 7
 8 # preCICE setup
 9 participant_name      = "Generator"
10 config_file_name      = "precice-config.xml"
11 solver_process_index = 0
12 solver_process_size  = 1
13 interface =
14     precice.Interface(
15                         participant_name,
16                         config_file_name,
17                         solver_process_index,
18                         solver_process_size
19                       )
20
21 # Get the preCICE mesh id
22 mesh_name  = "Generator-Mesh"
```

Define the coupling mesh

```
16                      config_file_name,
17                      solver_process_index,
18                      solver_process_size
19                  )
20
21  # Get the preCICE mesh id
22  mesh_name  = "Generator-Mesh"
23  mesh_id    = interface.get_mesh_id(mesh_name)
24
25  # Define the coupling mesh
26  vertices   = [[1, y0] for y0 in y[:-1]]
27  vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29  dt = 0.01
30  t = 0
31
32  while True:
```

Initialize and finalize preCICE

```
16                          config_file_name,
17                          solver_process_index,
18                          solver_process_size
19                        )
20
21 # Get the preCICE mesh id
22 mesh_name  = "Generator-Mesh"
23 mesh_id    = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices   = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
```

Initialize and finalize preCICE

```
25 # Define the coupling mesh
26 vertices   = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35   print("Generating data")
36   u = 1 - 2 * numpy.random.rand(n)
37
38   t = t + dt
39   if(t > 0.1):
40     break
41
42 interface.finalize()
```

Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35   print("Generating data")
36   u = 1 - 2 * numpy.random.rand(n)
37
38
39
40   t = t + dt
41   if(t > 0.1):
42     break
43
44 interface.finalize()
```

Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35   print("Generating data")
36   u = 1 - 2 * numpy.random.rand(n)
37
38
39
40   t = t + dt
41   if(t > 0.1):
42     break
43
44 interface.finalize()
```

Advance the coupling

```
27   vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35   print("Generating data")
36   u = 1 - 2 * numpy.random.rand(n)
37
38   interface.advance(dt)
39
40   t = t + dt
41   if(t > 0.1):
42     break
43
44 interface.finalize()
```

Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35    print("Generating data")
36    u = 1 - 2 * numpy.random.rand(n)
37
38    interface.advance(dt)
39
40    t = t + dt
41
42
43
44 interface.finalize()
```

Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35    print("Generating data")
36    u = 1 - 2 * numpy.random.rand(n)
37
38    precice_dt = interface.advance(dt)
39
40    t = t + dt
41
42
43
44 interface.finalize()
```

Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 precice_dt = interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35     dt = np.minimum(dt, precice_dt)
36
37     print("Generating data")
38     u = 1 - 2 * numpy.random.rand(n)
39
40     precice_dt = interface.advance(dt)
41
42     t = t + dt
43
44 interface.finalize()
```

Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 precice_dt = interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35   dt = np.minimum(dt, precice_dt)
36
37   print("Generating data")
38   u = 1 - 2 * numpy.random.rand(n)
39
40   precice_dt = interface.advance(dt)
41
42   t = t + dt
43
```

Not there yet, but let's run it

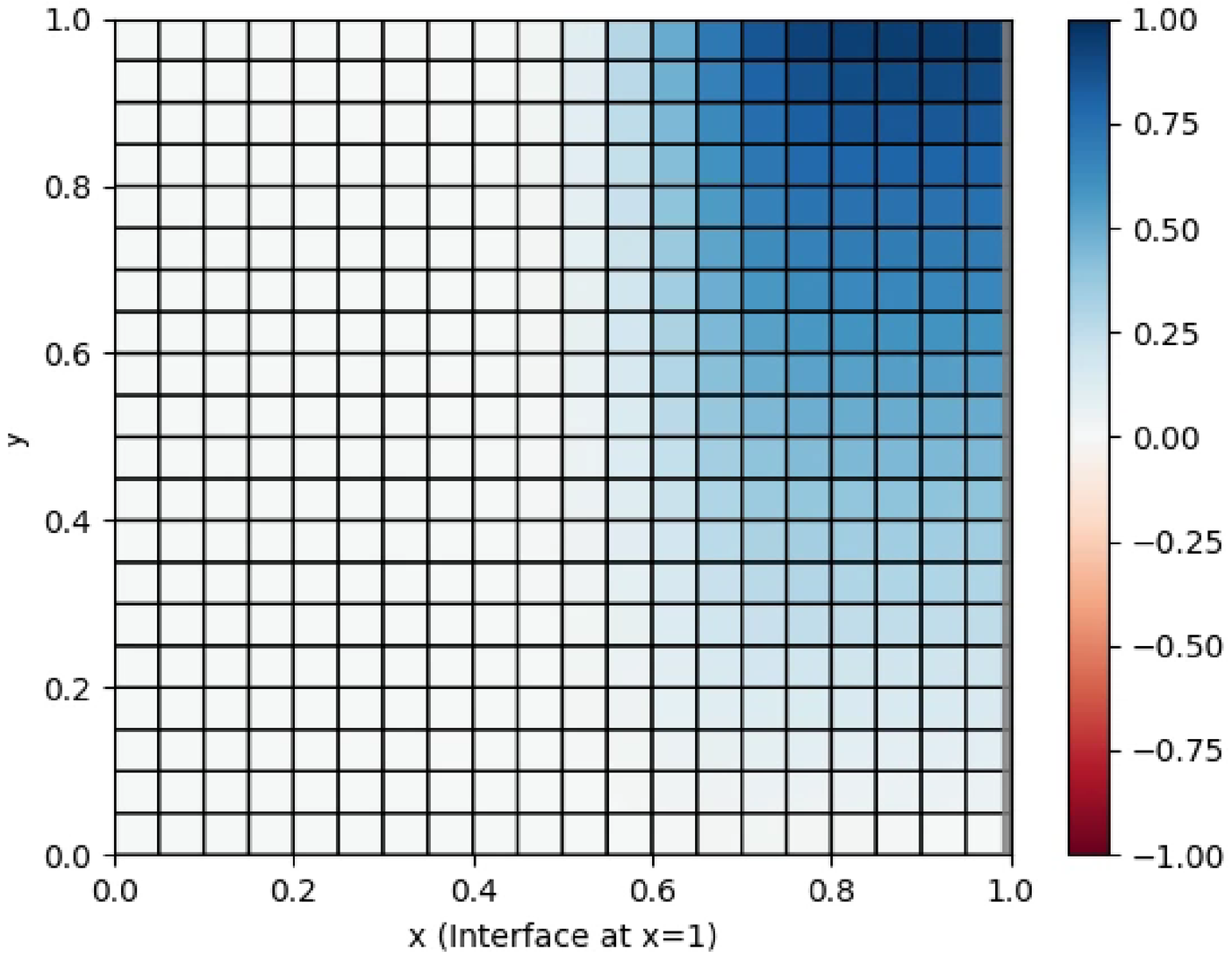
(similar changes in propagator.py - try it at home)

```
(base) ~/tutorial$ ls
Allclean  generator.py  precice-config.xml  propagator.py
(base) ~/tutorial$ python3 generator.py
---[precice]  This is preCICE version 2.0.2
---[precice]  Revision info: v2.0.2
---[precice]  Configuring preCICE with configuration: "precice-config.xml"
---[precice]  Setting up master communication to coupling partner/s
```

```
(base) ~/tutorial$ python3
```

```
[2] 0:bash*                                        "Magdalena" 21:48 20-Jun-20
```

Nothing happening?



Did we forget something?

Write & read data

```
20
21 # Get the preCICE mesh id
22 mesh_name  = "Generator-Mesh"
23 mesh_id    = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices   = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29
30
31
32
33 precice_dt = interface.initialize()
34
35 dt = 0.01
36 t = 0
```

Write & read data

```
20
21 # Get the preCICE mesh id
22 mesh_name  = "Generator-Mesh"
23 mesh_id    = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices   = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 # Get the exchanged data id
30 data_name = "Data"
31 data_id = interface.get_data_id(data_name, mesh_id)
32
33 precice_dt = interface.initialize()
34
35 dt = 0.01
36 t = 0
```

Write & read data

```
precice_dt = interface.initialize()

dt = 0.01
t = 0

while interface.is_coupling_ongoing():
  dt = np.minimum(dt, precice_dt)

  print("Generating data")
  u = 1 - 2 * numpy.random.rand(n)

  interface.write_block_scalar_data(data_id, vertex_ids, u)
  precice_dt = interface.advance(dt)
  # interface.read_block_scalar_data(data_id, vertex_ids, u)

  t = t + dt

interface.finalize()
```

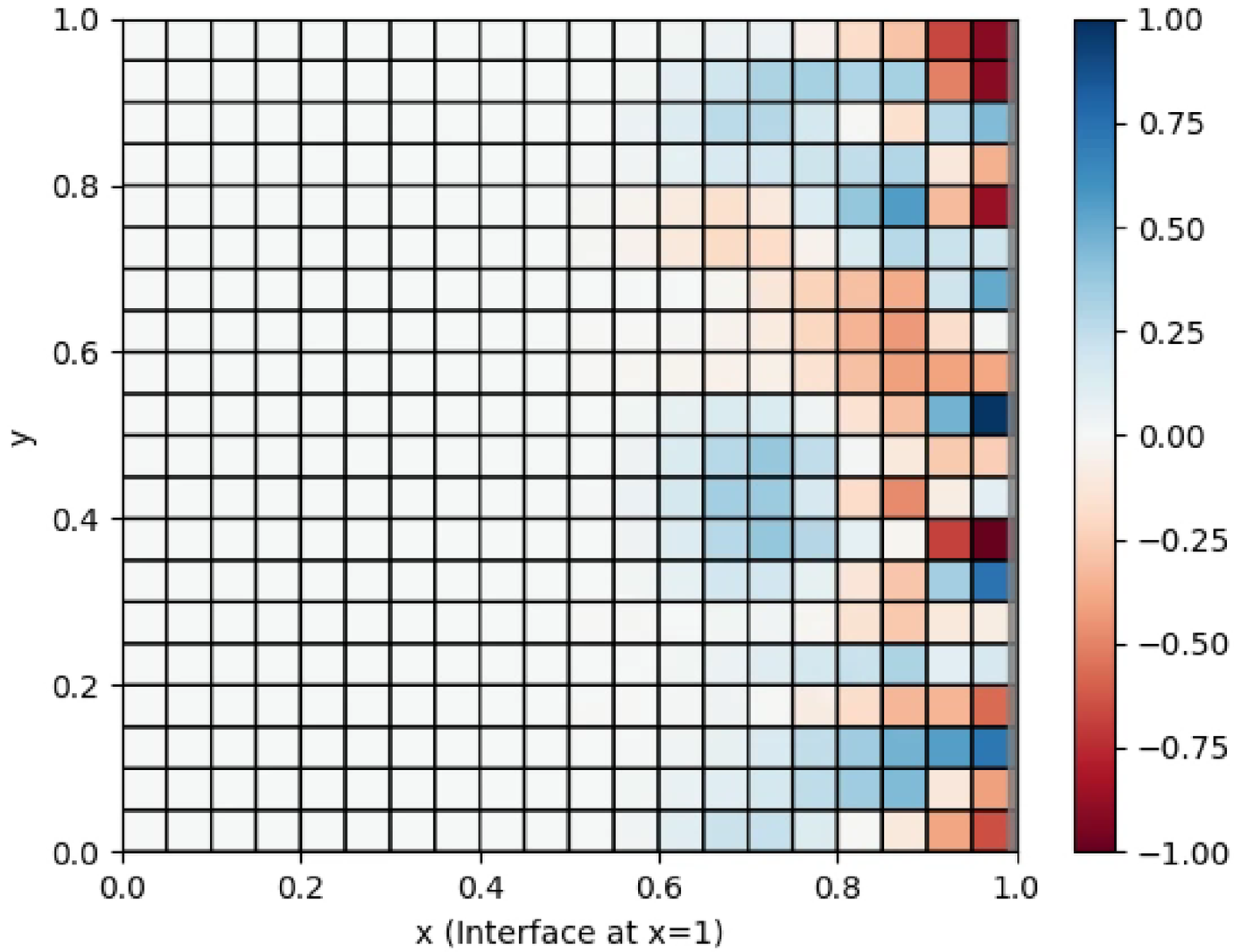
It should work now!

```
(base) ~/tutorial$ ls
Allclean  generator.py  precice-config.xml  propagator.py
(base) ~/tutorial$ python3 generator.py
---[precice]  This is preCICE version 2.0.2
---[precice]  Revision info: v2.0.2
---[precice]  Configuring preCICE with configuration: "precice-config.xml"
---[precice]  Setting up master communication to coupling partner/s
---[precice]  Masters are connected
---[precice]  Setting up preliminary slaves communication to coupling partner
/s
---[precice]  Prepare partition for mesh Generator-Mesh
---[precice]  Gather mesh Generator-Mesh
---[precice]  Send global mesh Generator-Mesh
---[precice]  Setting up slaves communication to coupling partner/s
---[precice]  Slaves are connected
---[precice]  it 1 of 1 | dt# 1 | t 0 of 0.1 | dt 0.01 | max dt 0.01 | ongoin
g yes | dt complete no |
Generating data
---[precice]  it 1 of 1 | dt# 2 | t 0.01 of 0.1 | dt 0.01 | max dt 0.01 | ong
oing yes | dt complete yes |
Generating data
---[precice]  it 1 of 1 | dt# 3 | t 0.02 of 0.1 | dt 0.01 | max dt 0.01 |
oing yes | dt complete yes |
Generating data
```

```
(base) ~/tutorial$ python3 propagator.py
---[precice]  This is preCICE version 2.0.2
---[precice]  Revision info: v2.0.2
---[precice]  Configuring preCICE with configuration: "precice-config.xml"
---[precice]  Setting up master communication to coupling partner/s
---[precice]  Masters are connected
---[precice]  Setting up preliminary slaves communication to coupling partne
r/s
---[precice]  Receive global mesh Generator-Mesh
---[precice]  Prepare partition for mesh Propagator-Mesh
---[precice]  Setting up slaves communication to coupling partner/s
---[precice]  Slaves are connected
---[precice]  Compute read mapping from mesh "Generator-Mesh" to mesh "Propa
gator-Mesh".
---[precice]  Mapping distance min:0 max:0 avg: 0 var: 0 cnt: 20
---[precice]  it 1 of 1 | dt# 1 | t 0 of 0.1 | dt 0.01 | max dt 0.01 | ongoi
ng yes | dt complete no |
```

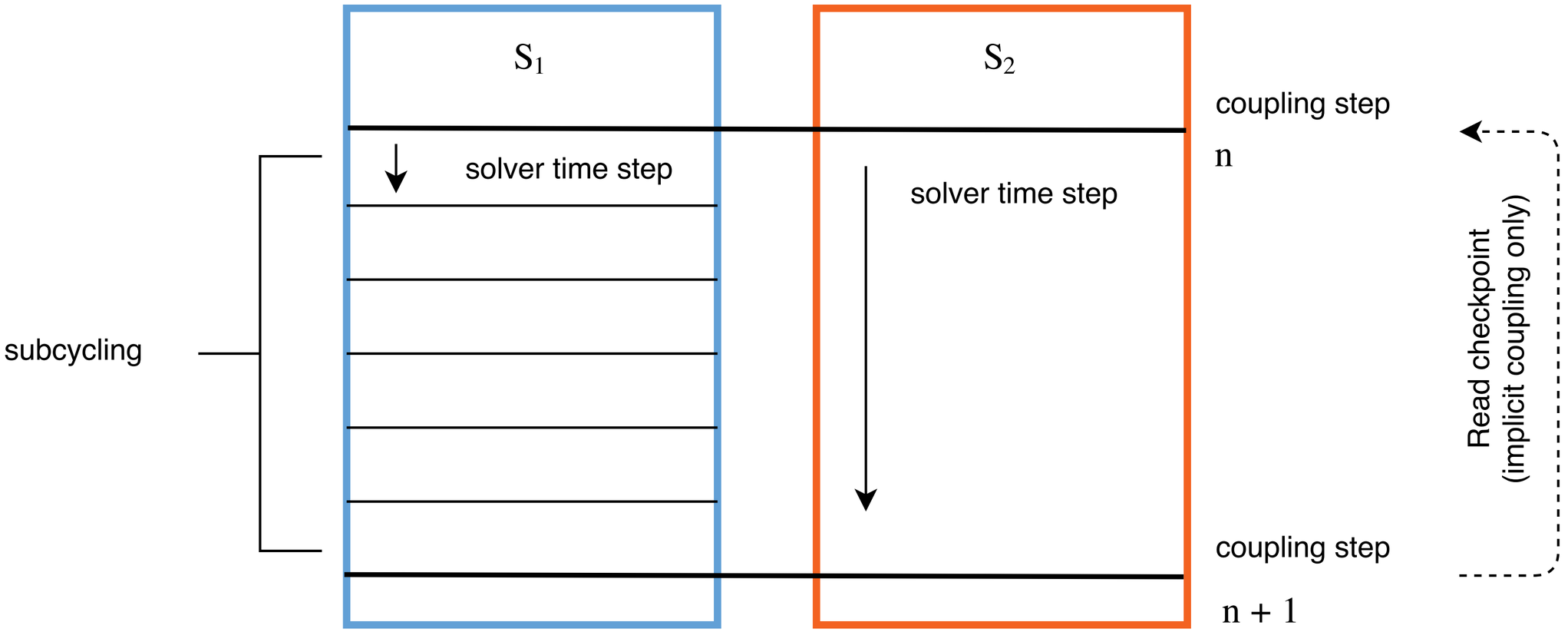
```
[5] 0:python3*                                                    "Magdalena" 00:36 21-Jun-20
```

Data is being transfered!



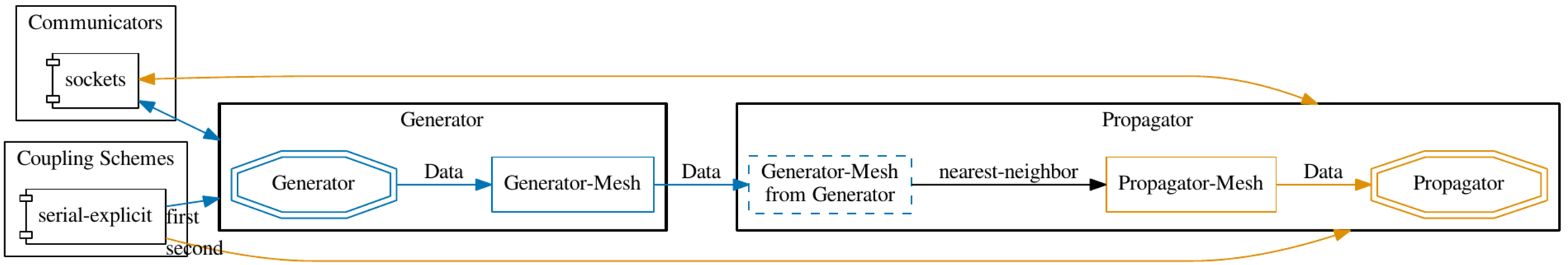
Most basic case: uni-directional, serial-explicit, nearest-neighbor mapping, ...

Side note: Subcycling



preCICE configuration file

Visual representation of precice-config.xml using the config visualizer:



preCICE configuration file

precice-config.xml:

```xml
<precice-configuration>
  <solver-interface dimensions="2">

  <data:scalar name="Data"/>

  <mesh name="Generator-Mesh">
    <use-data name="Data"/>
  </mesh>

  <mesh name="Propagator-Mesh">
    <use-data name="Data" />
  </mesh>

  <participant name="Generator">
    <use-mesh name="Generator-Mesh" provide="yes"/>
    <write-data name="Data" mesh="Generator-Mesh"/>
  </participant>
```

preCICE configuration file

precice-config.xml:

```xml
<precice-configuration>
  <solver-interface dimensions="2">

    <data:scalar name="Data"/>

    <mesh name="Generator-Mesh">
      <use-data name="Data"/>
    </mesh>

    <mesh name="Propagator-Mesh">
      <use-data name="Data" />
    </mesh>

    <participant name="Generator">
      <use-mesh name="Generator-Mesh" provide="yes"/>
      <write-data name="Data" mesh="Generator-Mesh"/>
    </participant>
```

preCICE configuration file

precice-config.xml:

```xml
<precice-configuration>
  <solver-interface dimensions="2">

  <data:scalar name="Data"/>

  <mesh name="Generator-Mesh">
    <use-data name="Data"/>
  </mesh>

  <mesh name="Propagator-Mesh">
    <use-data name="Data" />
  </mesh>

  <participant name="Generator">
    <use-mesh name="Generator-Mesh" provide="yes"/>
    <write-data name="Data" mesh="Generator-Mesh"/>
  </participant>
```

preCICE configuration file

precice-config.xml:

```
 7      <use-data name="Data"/>
 8    </mesh>
 9
10    <mesh name="Propagator-Mesh">
11      <use-data name="Data" />
12    </mesh>
13
14    <participant name="Generator">
15      <use-mesh name="Generator-Mesh" provide="yes"/>
16      <write-data name="Data" mesh="Generator-Mesh"/>
17    </participant>
18
19    <participant name="Propagator">
20      <use-mesh name="Generator-Mesh" from="Generator"/>
21      <use-mesh name="Propagator-Mesh" provide="yes"/>
22      <mapping:nearest-neighbor direction="read"
23        from="Generator-Mesh" to="Propagator-Mesh"
```

preCICE configuration file

precice-config.xml:

```
14    <participant name="Generator">
15      <use-mesh name="Generator-Mesh" provide="yes"/>
16      <write-data name="Data" mesh="Generator-Mesh"/>
17    </participant>
18
19    <participant name="Propagator">
20      <use-mesh name="Generator-Mesh" from="Generator"/>
21      <use-mesh name="Propagator-Mesh" provide="yes"/>
22      <mapping:nearest-neighbor direction="read"
23        from="Generator-Mesh" to="Propagator-Mesh"
24        constraint="consistent"/>
25      <read-data name="Data" mesh="Propagator-Mesh" />
26    </participant>
27
28    <m2n:sockets from="Generator" to="Propagator"/>
29
30    <coupling-scheme:serial-explicit>
```

preCICE configuration file

precice-config.xml:

```
14    <participant name="Generator">
15      <use-mesh name="Generator-Mesh" provide="yes"/>
16      <write-data name="Data" mesh="Generator-Mesh"/>
17    </participant>
18
19    <participant name="Propagator">
20      <use-mesh name="Generator-Mesh" from="Generator"/>
21      <use-mesh name="Propagator-Mesh" provide="yes"/>
22      <mapping:nearest-neighbor direction="read"
23        from="Generator-Mesh" to="Propagator-Mesh"
24        constraint="consistent"/>
25      <read-data name="Data" mesh="Propagator-Mesh" />
26    </participant>
27
28    <m2n:sockets from="Generator" to="Propagator"/>
29
30    <coupling-scheme:serial-explicit>
```

preCICE configuration file

precice-config.xml:

```
20      <use-mesh name="Generator-Mesh" from="Generator"/>
21      <use-mesh name="Propagator-Mesh" provide="yes"/>
22      <mapping:nearest-neighbor direction="read"
23        from="Generator-Mesh" to="Propagator-Mesh"
24        constraint="consistent"/>
25      <read-data name="Data" mesh="Propagator-Mesh" />
26    </participant>
27
28    <m2n:sockets from="Generator" to="Propagator"/>
29
30    <coupling-scheme:serial-explicit>
31      <participants first="Generator" second="Propagator"/>
32      <time-window-size value="0.01"/>
33      <max-time value="0.1"/>
34      <exchange data="Data" mesh="Generator-Mesh"
35        from="Generator" to="Propagator"/>
36    </coupling-scheme:serial-explicit>
```

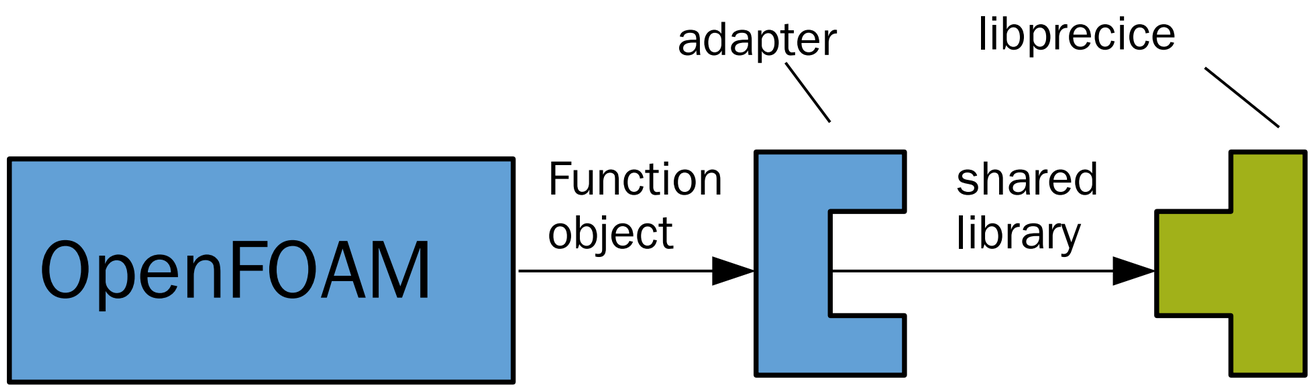
preCICE configuration file

precice-config.xml:

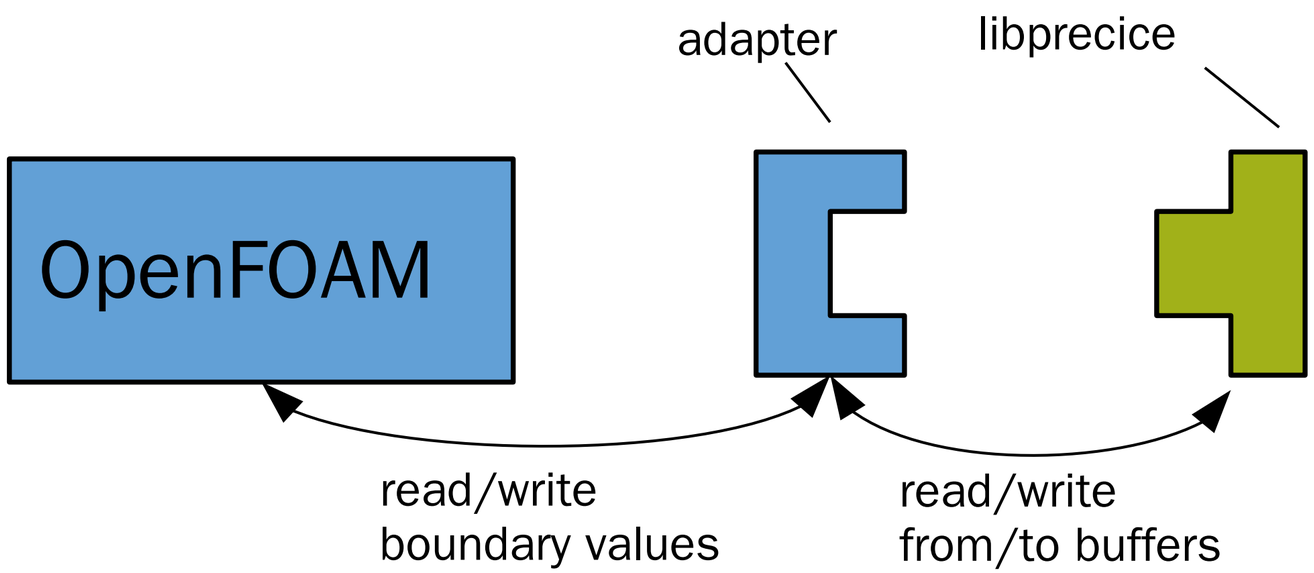
```
23        from="Generator-Mesh" to="Propagator-Mesh"
24        constraint="consistent"/>
25     <read-data name="Data" mesh="Propagator-Mesh" />
26   </participant>
27
28   <m2n:sockets from="Generator" to="Propagator"/>
29
30   <coupling-scheme:serial-explicit>
31     <participants first="Generator" second="Propagator"/>
32     <time-window-size value="0.01"/>
33     <max-time value="0.1"/>
34     <exchange data="Data" mesh="Generator-Mesh"
35       from="Generator" to="Propagator"/>
36   </coupling-scheme:serial-explicit>
37
38   </solver-interface>
39 </precice-configuration>
```

Level 2: Using the OpenFOAM adapter

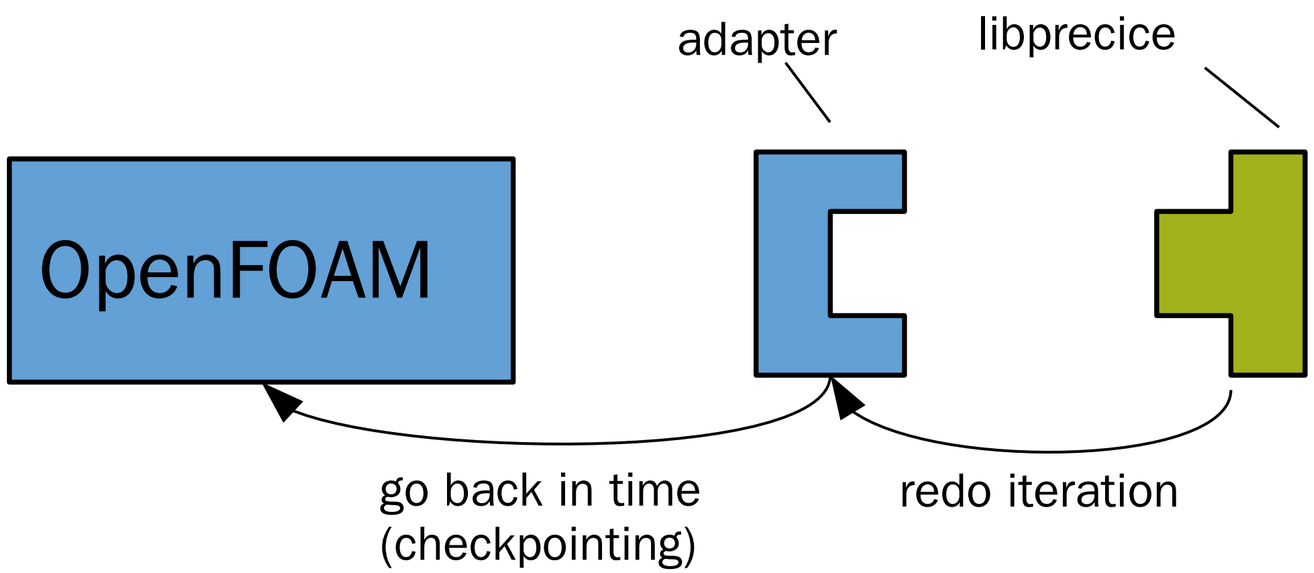
What does the adapter do?



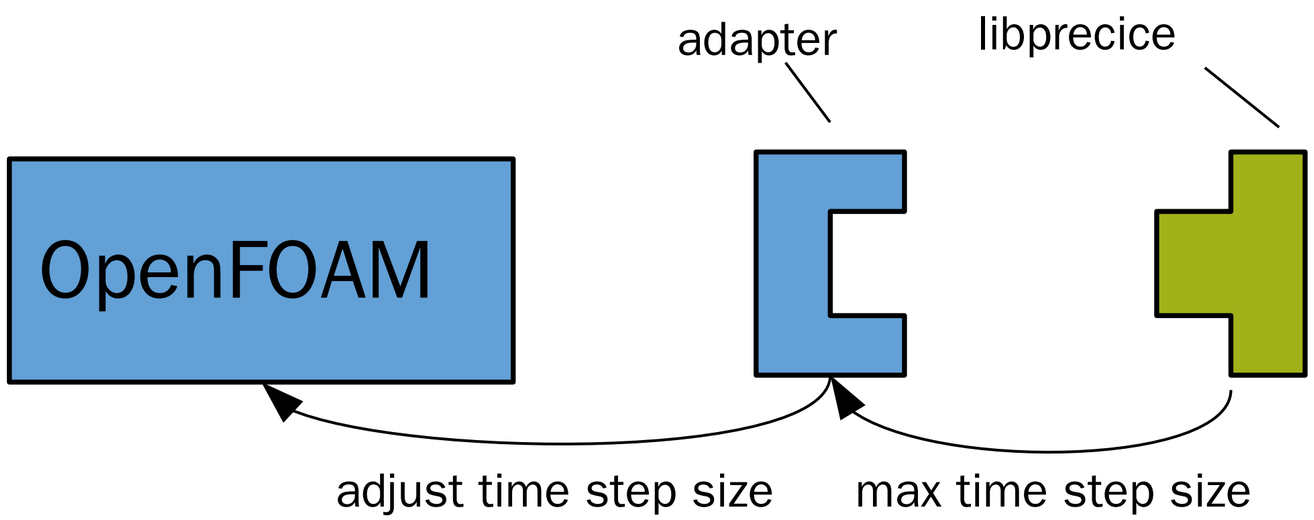
What does the adapter do?



What does the adapter do?



What does the adapter do?



Dependencies

- preCICE v2 (e.g. packages for Ubuntu)
- Recent OpenFOAM (e.g. v1706-v1912 or 4-7)
- preCICE OpenFOAM adapter (latest master)

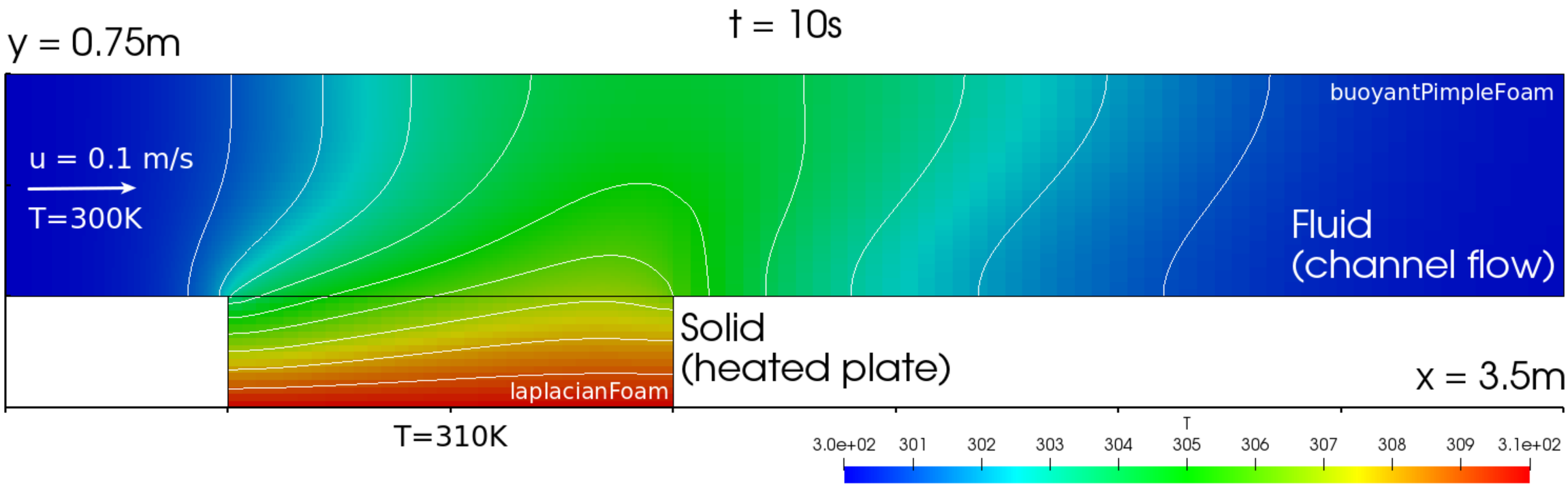
Building

```
openfoam-adapter/ $ ./Allwmake

# Debugging output in Allwmake.log, wmake.log, ldd.log
```

Building

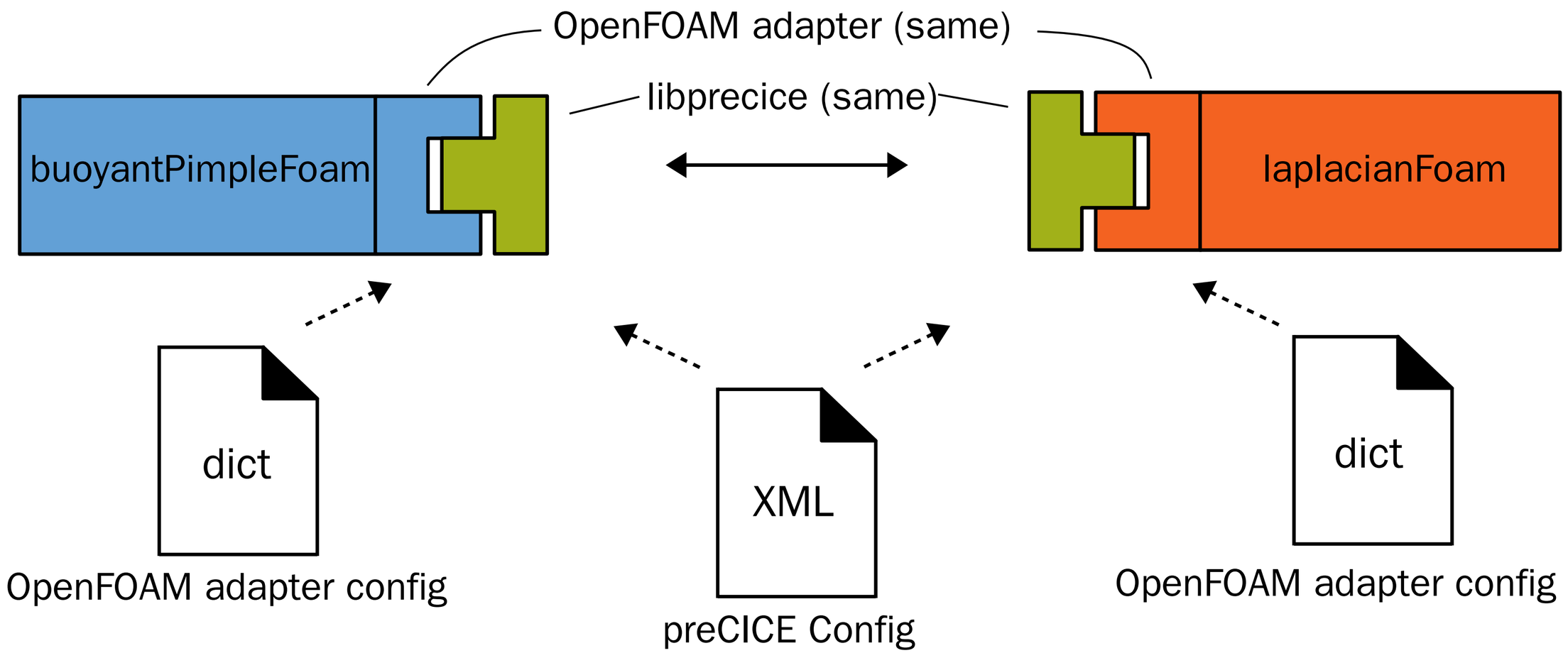
```
~/openfoam-adapter$ ls
Adapter.C  Allwmake            CouplingDataUser.H  Interface.H  preciceAdapterFunctionObject.C  tutorials
Adapter.H  CHT                 FSI                 LICENSE      preciceAdapterFunctionObject.H  Utilities.C
Allclean   CouplingDataUser.C  Interface.C         Make         README.md                       Utilities.H
~/openfoam-adapter$ ./Allclean
Cleaning complete!
~/openfoam-adapter$ ./Allwmake
Building the OpenFOAM adapter for preCICE...

Current OpenFOAM environment:
  WM_PROJECT = OpenFOAM
  WM_PROJECT_VERSION = v1912

The adapter will be built into:
  ADAPTER_TARGET_DIR    = /home/tester/OpenFOAM/tester-v1912/platforms/linux64GccDPInt32Opt/lib

The following building options will be used:
  ADAPTER_PREP_FLAGS    = -DADAPTER_DEBUG_MODE
  ADAPTER_WMAKE_OPTIONS =

Dependencies (preCICE) will be located using the following environment variables:
  ADAPTER_PRECICE_ROOT  =
      preCICE dependencies: not specified (ok if preCICE is built as a shared library)
  ADAPTER_PKG_CONFIG_CFLAGS       =
  ADAPTER_PKG_CONFIG_LIBS         = -lprecice
  ADAPTER_GLOBAL_CPLUS_INC_PATHS  =
  ADAPTER_GLOBAL_LD_LIBRARY_PATHS = -L/usr/lib/openfoam/openf[illegible]912/platforms/linux64GccDPInt32Opt/lib/openmpi-system -L/usr/lib/
x86_64-linux-gnu/openmpi/lib -L/home/tester/OpenFOAM/tester-v[illegible]tforms/linux64GccDPInt32Opt/lib -L/usr/lib/openfoam/openfoam1
912/site/1912/platforms/linux64GccDPInt32Opt/lib -L/usr/lib/o[illegible]openfoam1912/platforms/linux64GccDPInt32Opt/lib -L/usr/lib/op
enfoam/openfoam1912/platforms/linux64GccDPInt32Opt/lib/dummy
  ADAPTER_GLOBAL_LIBRARY_PATHS    =

Building with WMake (see the wmake.log log file)...
```

Tutorial: Flow over a heated plate



Find the case in github.com/precice/openfoam-adapter/tutorials.

Configuration: overview



Configuration: files

```
.
├── Allclean
├── Allrun
├── Allrun_parallel
├── Fluid
│   ├── 0
│   │   ├── alphat
│   │   ├── epsilon
│   │   ├── k
│   │   ├── nut
│   │   ├── p
│   │   ├── p_rgh
│   │   ├── T
│   │   └── U
│   ├── constant
│   │   ├── g
│   │   ├── thermophysicalProperties
```

Configuration: files

```
13 │   │   ├── T
14 │   │   └── U
15 │   ├── constant
16 │   │   ├── g
17 │   │   ├── thermophysicalProperties
18 │   │   └── turbulenceProperties
19 │   ├── Fluid.foam
20 │   └── system
21 │       ├── blockMeshDict
22 │       ├── controlDict
23 │       ├── decomposeParDict
24 │       ├── fvSchemes
25 │       ├── fvSolution
26 │       └── preciceDict
27 ├── overview.png
28 ├── precice-config.xml
29 ├── README.md
```

Enabling the adapter

```
// Fluid/system/controlDict

functions
{
preCICE_Adapter
{

type preciceAdapterFunctionObject;
libs ("libpreciceAdapterFunctionObject.s

}
}
```

```
// Solid/system/controlDict

functions
{
preCICE_Adapter
{

type preciceAdapterFunctionO
libs ("libpreciceAdapterFunc

}
}
```

OpenFOAM adapter config

```
// Fluid/system/preciceDict

preciceConfig "precice-config.xml

participant Fluid;

modules (CHT);

interfaces
{
  Interface1
  {
    mesh       Fluid-Mesh;
    patches    (interface);

    readData
    (
```

```
// Solid/system/preciceDict

preciceConfig "precice-config.xml

participant Solid;

modules (CHT);

interfaces
{
  Interface1
  {
    mesh       Solid-Mesh;
    patches    (interface);

    readData
    (
```

The interface patch

```
// Fluid/system/blockMeshDict

boundary
(
    interface
    {
        type wall;
        faces
        (
            (4 0 1 5)
        );
    }

    // ...
);
```

```
// Solid/system/blockMeshDict

boundary
(
    interface
    {
        type wall;
        faces
        (
            (7 6 2 3)
        );
    }

    // ...
);
```

OpenFOAM boundary conditions

```
// Fluid/0/T

internalField uniform 300;

boundaryField
{
    interface
    {
        type        fixedGradient;
        gradient    uniform 0;
    }
    inlet
    {
        type        fixedValue;
        value       $internalField;
    }
    outlet
```

```
// Solid/0/T

internalField uniform 310;

boundaryField
{
    interface
    {
        type        fixedValue;
        value       $internalField;
    }
    left
    {
        type        zeroGradient;
    }
    // ...
}
```

precice-config.xml

```xml
<precice-configuration>

    <solver-interface dimensions="3">

    <data:scalar name="Temperature"/>
    <data:scalar name="Heat-Flux"/>

    <mesh name="Fluid-Mesh">
        <use-data name="Temperature"/>
        <use-data name="Heat-Flux"/>
    </mesh>

    <mesh name="Solid-Mesh">
        <use-data name="Temperature"/>
        <use-data name="Heat-Flux"/>
    </mesh>
```

precice-config.xml

```xml
<precice-configuration>

    <solver-interface dimensions="3">

    <data:scalar name="Temperature"/>
    <data:scalar name="Heat-Flux"/>

    <mesh name="Fluid-Mesh">
        <use-data name="Temperature"/>
        <use-data name="Heat-Flux"/>
    </mesh>

    <mesh name="Solid-Mesh">
        <use-data name="Temperature"/>
        <use-data name="Heat-Flux"/>
    </mesh>
```

precice-config.xml

```
 4
 5       <data:scalar name="Temperature"/>
 6       <data:scalar name="Heat-Flux"/>
 7
 8       <mesh name="Fluid-Mesh">
 9           <use-data name="Temperature"/>
10           <use-data name="Heat-Flux"/>
11       </mesh>
12
13       <mesh name="Solid-Mesh">
14           <use-data name="Temperature"/>
15           <use-data name="Heat-Flux"/>
16       </mesh>
17
18       <participant name="Fluid">
19           <use-mesh name="Fluid-Mesh" provide="yes"/>
20           <use-mesh name="Solid-Mesh" from="Solid"/>
```

precice-config.xml

```
14          <use-data name="Temperature"/>
15          <use-data name="Heat-Flux"/>
16      </mesh>
17
18      <participant name="Fluid">
19          <use-mesh name="Fluid-Mesh" provide="yes"/>
20          <use-mesh name="Solid-Mesh" from="Solid"/>
21          <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22          <write-data name="Temperature" mesh="Fluid-Mesh"/>
23          <mapping:nearest-neighbor direction="read"
24            from="Solid-Mesh" to="Fluid-Mesh"
25            constraint="consistent"/>
26      </participant>
27
28      <participant name="Solid">
29          <use-mesh name="Fluid-Mesh" from="Fluid"/>
30          <use-mesh name="Solid-Mesh" provide="yes"/>
```

precice-config.xml

```
14          <use-data name="Temperature"/>
15          <use-data name="Heat-Flux"/>
16      </mesh>
17
18      <participant name="Fluid">
19          <use-mesh name="Fluid-Mesh" provide="yes"/>
20          <use-mesh name="Solid-Mesh" from="Solid"/>
21          <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22          <write-data name="Temperature" mesh="Fluid-Mesh"/>
23          <mapping:nearest-neighbor direction="read"
24            from="Solid-Mesh" to="Fluid-Mesh"
25            constraint="consistent"/>
26      </participant>
27
28      <participant name="Solid">
29          <use-mesh name="Fluid-Mesh" from="Fluid"/>
30          <use-mesh name="Solid-Mesh" provide="yes"/>
```

precice-config.xml

```
14          <use-data name="Temperature"/>
15          <use-data name="Heat-Flux"/>
16      </mesh>
17
18      <participant name="Fluid">
19          <use-mesh name="Fluid-Mesh" provide="yes"/>
20          <use-mesh name="Solid-Mesh" from="Solid"/>
21          <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22          <write-data name="Temperature" mesh="Fluid-Mesh"/>
23          <mapping:nearest-neighbor direction="read"
24            from="Solid-Mesh" to="Fluid-Mesh"
25            constraint="consistent"/>
26      </participant>
27
28      <participant name="Solid">
29          <use-mesh name="Fluid-Mesh" from="Fluid"/>
30          <use-mesh name="Solid-Mesh" provide="yes"/>
```

precice-config.xml

```
14          <use-data name="Temperature"/>
15          <use-data name="Heat-Flux"/>
16      </mesh>
17
18      <participant name="Fluid">
19          <use-mesh name="Fluid-Mesh" provide="yes"/>
20          <use-mesh name="Solid-Mesh" from="Solid"/>
21          <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22          <write-data name="Temperature" mesh="Fluid-Mesh"/>
23          <mapping:nearest-neighbor direction="read"
24            from="Solid-Mesh" to="Fluid-Mesh"
25            constraint="consistent"/>
26      </participant>
27
28      <participant name="Solid">
29          <use-mesh name="Fluid-Mesh" from="Fluid"/>
30          <use-mesh name="Solid-Mesh" provide="yes"/>
```

precice-config.xml

```
24          from="Solid-Mesh" to="Fluid-Mesh"
25          constraint="consistent"/>
26    </participant>
27
28    <participant name="Solid">
29        <use-mesh name="Fluid-Mesh" from="Fluid"/>
30        <use-mesh name="Solid-Mesh" provide="yes"/>
31        <read-data name="Temperature" mesh="Solid-Mesh"/>
32        <write-data name="Heat-Flux" mesh="Solid-Mesh"/>
33        <mapping:nearest-neighbor direction="read"
34          from="Fluid-Mesh" to="Solid-Mesh"
35          constraint="consistent"/>
36    </participant>
37
38    <m2n:sockets from="Fluid" to="Solid"/>
39
40    <coupling-scheme:serial-implicit>
```

precice-config.xml

```
39
40      <coupling-scheme:serial-implicit>
41          <time-window-size value="0.01"/>
42          <max-time value="1"/>
43          <participants first="Fluid" second="Solid"/>
44          <exchange data="Temperature" mesh="Fluid-Mesh"
45            from="Fluid" to="Solid"/>
46          <exchange data="Heat-Flux" mesh="Solid-Mesh"
47            from="Solid" to="Fluid"/>
48          <max-iterations value="200"/>
49          <relative-convergence-measure limit="1.0e-6"
50            data="Temperature" mesh="Fluid-Mesh"/>
51          <acceleration:IQN-ILS>
52              <data mesh="Solid-Mesh" name="Heat-Flux" />
53              <initial-relaxation value="0.01" />
54              <max-used-iterations value="80" />

55              <time-windows-reused value="10" />
```

precice-config.xml

```
39
40      <coupling-scheme:serial-implicit>
41          <time-window-size value="0.01"/>
42          <max-time value="1"/>
43          <participants first="Fluid" second="Solid"/>
44          <exchange data="Temperature" mesh="Fluid-Mesh"
45            from="Fluid" to="Solid"/>
46          <exchange data="Heat-Flux" mesh="Solid-Mesh"
47            from="Solid" to="Fluid"/>
48          <max-iterations value="200"/>
49          <relative-convergence-measure limit="1.0e-6"
50            data="Temperature" mesh="Fluid-Mesh"/>
51          <acceleration:IQN-ILS>
52              <data mesh="Solid-Mesh" name="Heat-Flux" />
53              <initial-relaxation value="0.01" />
54              <max-used-iterations value="80" />

55              <time-windows-reused value="10" />
```

precice-config.xml

```
39
40      <coupling-scheme:serial-implicit>
41          <time-window-size value="0.01"/>
42          <max-time value="1"/>
43          <participants first="Fluid" second="Solid"/>
44          <exchange data="Temperature" mesh="Fluid-Mesh"
45            from="Fluid" to="Solid"/>
46          <exchange data="Heat-Flux" mesh="Solid-Mesh"
47            from="Solid" to="Fluid"/>
48          <max-iterations value="200"/>
49          <relative-convergence-measure limit="1.0e-6"
50            data="Temperature" mesh="Fluid-Mesh"/>
51          <acceleration:IQN-ILS>
52              <data mesh="Solid-Mesh" name="Heat-Flux" />
53              <initial-relaxation value="0.01" />
54              <max-used-iterations value="80" />

55              <time-windows-reused value="10" />
```

precice-config.xml

```
39
40      <coupling-scheme:serial-implicit>
41          <time-window-size value="0.01"/>
42          <max-time value="1"/>
43          <participants first="Fluid" second="Solid"/>
44          <exchange data="Temperature" mesh="Fluid-Mesh"
45            from="Fluid" to="Solid"/>
46          <exchange data="Heat-Flux" mesh="Solid-Mesh"
47            from="Solid" to="Fluid"/>
48          <max-iterations value="200"/>
49          <relative-convergence-measure limit="1.0e-6"
50            data="Temperature" mesh="Fluid-Mesh"/>
51          <acceleration:IQN-ILS>
52              <data mesh="Solid-Mesh" name="Heat-Flux" />
53              <initial-relaxation value="0.01" />
54              <max-used-iterations value="80" />

55              <time-windows-reused value="10" />
```

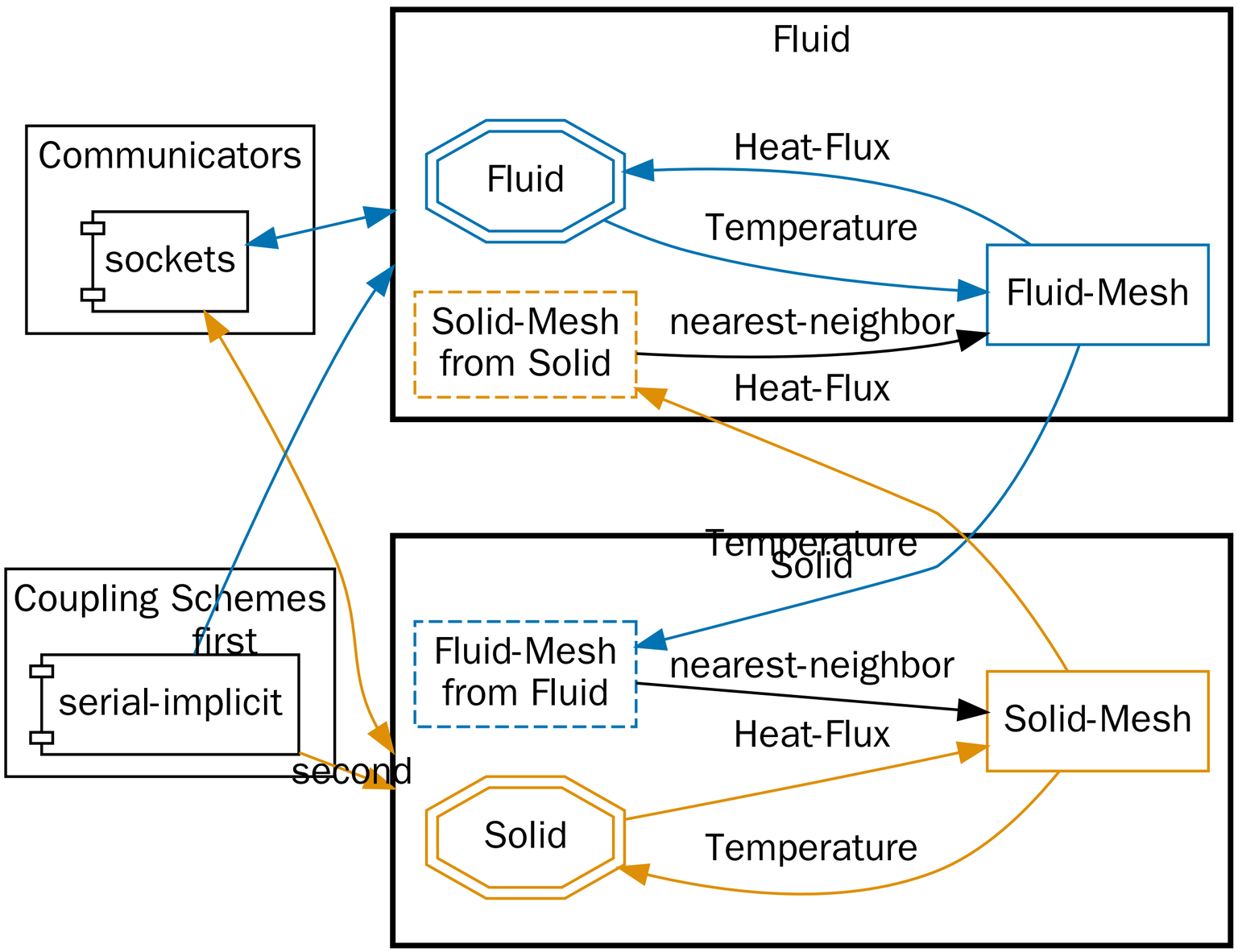
precice-config.xml

```
40      <coupling-scheme:serial-implicit>
41          <time-window-size value="0.01"/>
42          <max-time value="1"/>
43          <participants first="Fluid" second="Solid"/>
44          <exchange data="Temperature" mesh="Fluid-Mesh"
45            from="Fluid" to="Solid"/>
46          <exchange data="Heat-Flux" mesh="Solid-Mesh"
47            from="Solid" to="Fluid"/>
48          <max-iterations value="200"/>
49          <relative-convergence-measure limit="1.0e-6"
50            data="Temperature" mesh="Fluid-Mesh"/>
51          <acceleration:IQN-ILS>
52              <data mesh="Solid-Mesh" name="Heat-Flux" />
53              <initial-relaxation value="0.01" />
54              <max-used-iterations value="80" />

55              <time-windows-reused value="10" />
56              <filter type="QR1" limit="1e-8" />
```

precice-config.xml

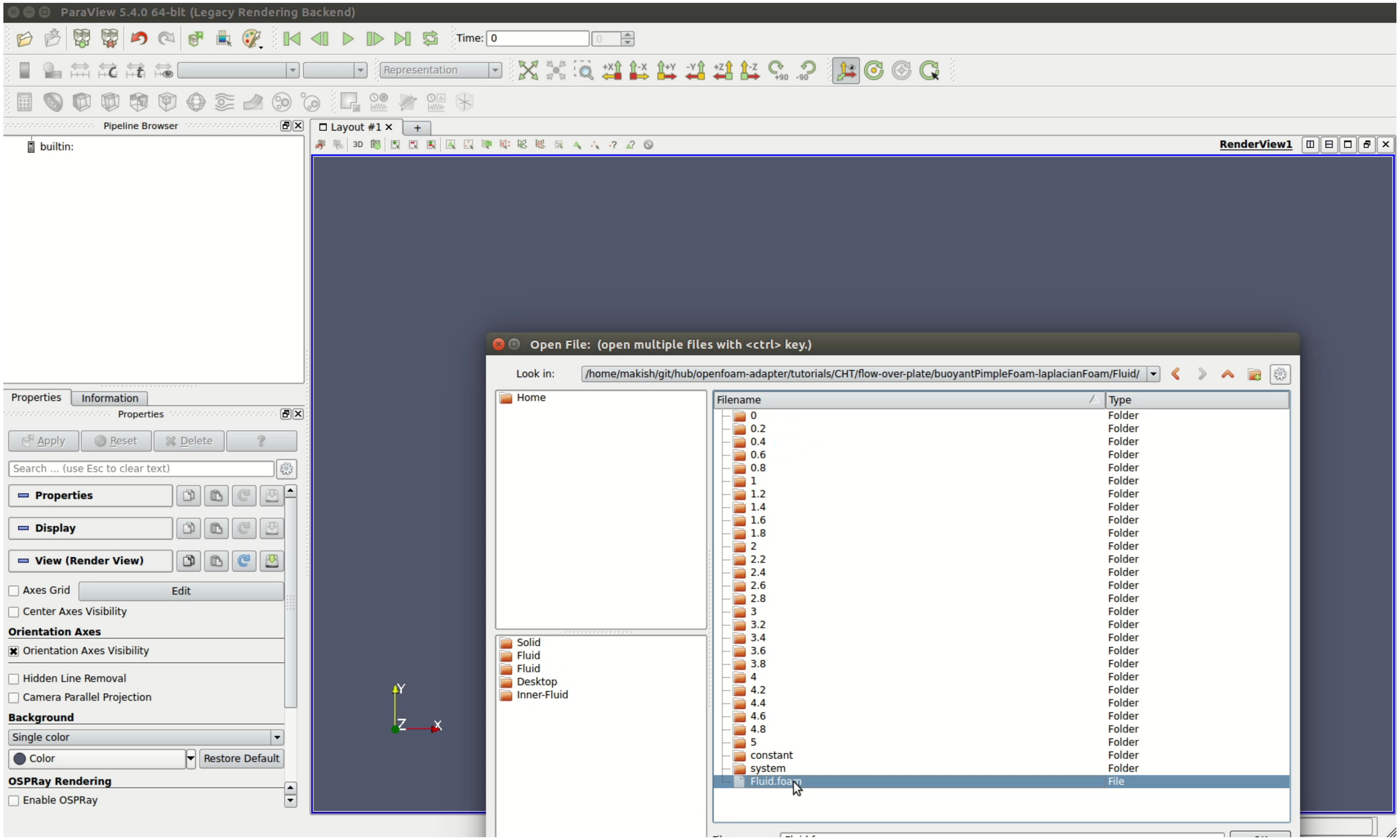
```
45            from="Fluid" to="Solid"/>
46        <exchange data="Heat-Flux" mesh="Solid-Mesh"
47          from="Solid" to="Fluid"/>
48        <max-iterations value="200"/>
49        <relative-convergence-measure limit="1.0e-6"
50          data="Temperature" mesh="Fluid-Mesh"/>
51        <acceleration:IQN-ILS>
52            <data mesh="Solid-Mesh" name="Heat-Flux" />
53            <initial-relaxation value="0.01" />
54            <max-used-iterations value="80" />

55            <time-windows-reused value="10" />
56            <filter type="QR1" limit="1e-8" />
57        </acceleration:IQN-ILS>
58    </coupling-scheme:serial-implicit>
59
60    </solver-interface>
61
```

precice-config.xml



Visual representation of precice-config.xml using the config visualizer

```
---[preciceAdapter] [DEBUG]   - mesh         : Fluid-Mesh                  |(base) ~/git/hub/openfoam-adapter/tutorials/CHT/flow-over-plate/buoyantPimpl
---[preciceAdapter] [DEBUG]     locations    : faceCenters                 |eFoam-laplacianFoam [master]$
---[preciceAdapter] [DEBUG]     connectivity : 0                           |
---[preciceAdapter] [DEBUG]     patches      :                             |
---[preciceAdapter] [DEBUG]       - interface                             |
---[preciceAdapter] [DEBUG]     writeData    :                             |
---[preciceAdapter] [DEBUG]       - Temperature                           |
---[preciceAdapter] [DEBUG]     readData     :                             |
---[preciceAdapter] [DEBUG]       - Heat-Flux                             |
---[preciceAdapter] [DEBUG] Configuring the CHT module...                  |
---[preciceAdapter] [DEBUG]     user-defined solver type :                 |
---[preciceAdapter] [DEBUG]     temperature field name : T                 |
---[preciceAdapter] [DEBUG]     conductivity name for basic solvers : k    |
---[preciceAdapter] [DEBUG]     density name for incompressible solvers : rho|
---[preciceAdapter] [DEBUG]     heat capacity name for incompressible solvers|
 : Cp                                                                      |
---[preciceAdapter] [DEBUG]     Prandtl number name for incompressible solver|
s : Pr                                                                     |
---[preciceAdapter] [DEBUG]     Turbulent thermal diffusivity field name for |
incompressible solvers : alphat                                           |
---[preciceAdapter] [DEBUG] Unknown solver type. Determining the solver type.|
..                                                                        |
---[preciceAdapter] [DEBUG] Automatically determined solver type : compre  |
le                                                                        |
---[preciceAdapter] [DEBUG] Checking the timestep type (fixed vs adjustab  |
..                                                                        |
---[preciceAdapter] [DEBUG]   Timestep type: fixed.                        |
---[preciceAdapter] [DEBUG] Creating the preCICE solver interface...       |
---[preciceAdapter] [DEBUG]   Number of processes: 1                       |
---[preciceAdapter] [DEBUG]   MPI rank: 0                                  |
---[precice]  This is preCICE version 2.0.2                               |
---[precice]  Revision info: v2.0.2                                       |
---[precice]  Configuring preCICE with configuration: "precice-config.xml"|
---[preciceAdapter] [DEBUG]   preCICE solver interface was created.        |
---[preciceAdapter] [DEBUG] Creating interfaces...                         |
---[preciceAdapter] [DEBUG] Number of face centres: 161                    |
---[preciceAdapter] [DEBUG] Interface created on mesh Fluid-Mesh           |
---[preciceAdapter] [DEBUG] Adding coupling data writers...                |
---[preciceAdapter] [DEBUG] Added writer: Temperature.                     |
---[preciceAdapter] [DEBUG] Adding coupling data readers...                |
---[preciceAdapter] [DEBUG] Constructed KappaEff_Compressible.            |
---[preciceAdapter] [DEBUG] Added reader: Heat Flux for compressible solvers.|
---[preciceAdapter] [DEBUG] Initalizing the preCICE solver interface...    |
---[precice]  Setting up master communication to coupling partner/s       |
                                                                          |
[0] 0:bash*                                                  "Magdalena" 00:49 23-Jun-20
```



"Flickering"? Run ./removeObsoleteFolders.sh first.

Level 3: Coupling OpenFOAM with other solvers

Other tutorials

```
tutorials
├── CHT
│   ├── flow-over-plate
│   │   ├── buoyantPimpleFoam-laplacianFoam
│   │   ├── buoyantPimpleFoam-fenics
│   │   └── buoyantPimpleFoam-nutils
│   └── heat_exchanger
│       └── buoyantSimpleFoam-CalculiX
│
├── FSI
│   ├── 3D_Tube
│   │   └── OpenFOAM-CalculiX
│   ├── cylinderFlap
│   │   ├── OpenFOAM-CalculiX
│   │   ├── OpenFOAM-deal.II
│   │   └── OpenFOAM-FEniCS
│   ├── flap_perp
```

See github.com/precice/tutorials.

Other tutorials

```
tutorials
├── CHT
│   ├── flow-over-plate
│   │   ├── buoyantPimpleFoam-laplacianFoam
│   │   ├── buoyantPimpleFoam-fenics
│   │   └── buoyantPimpleFoam-nutils
│   └── heat_exchanger
│       └── buoyantSimpleFoam-CalculiX
│
├── FSI
│   ├── 3D_Tube
│   │   └── OpenFOAM-CalculiX
│   ├── cylinderFlap
│   │   ├── OpenFOAM-CalculiX
│   │   ├── OpenFOAM-deal.II
│   │   └── OpenFOAM-FEniCS
│   ├── flap_perp
```

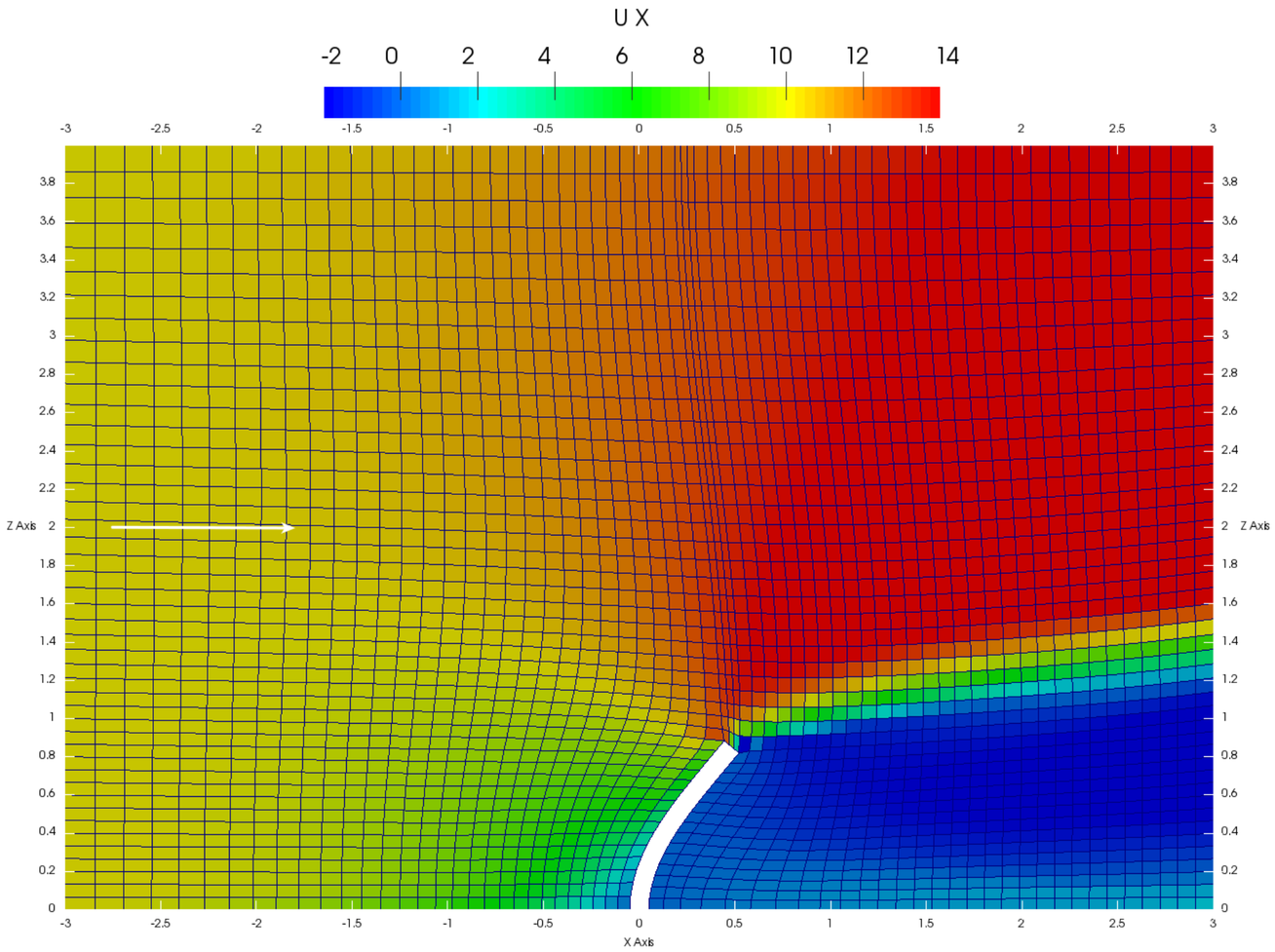
See github.com/precice/tutorials.

Other tutorials

```
 9 │
10 ├── FSI
11 │   ├── 3D_Tube
12 │   │   └── OpenFOAM-CalculiX
13 │   ├── cylinderFlap
14 │   │   ├── OpenFOAM-CalculiX
15 │   │   ├── OpenFOAM-deal.II
16 │   │   └── OpenFOAM-FEniCS
17 │   ├── flap_perp
18 │   │   ├── OpenFOAM-CalculiX
19 │   │   ├── OpenFOAM-deal.II
20 │   │   ├── OpenFOAM-FEniCS
21 │   │   └── SU2-CalculiX
22 │
23 ├── HT
24 │   └── partitioned-heat
25 │       └── fenics-fenics
```

See github.com/precice/tutorials.

Tutorial: Channel with a perpendicular flap



Find the case in github.com/precice/tutorials/FSI/flap_perp_2D/OpenFOAM-deal.II.

Dependencies

- preCICE v2 (e.g. packages for Ubuntu)
  - Build with PETSc (only for parallel && RBF)
- Recent OpenFOAM (e.g. v1706-v1912, 4-7)
- preCICE OpenFOAM adapter (latest master)
- deal.II 9.2
- preCICE deal.II adapter/example

Configure OpenFOAM

```
// Fluid/0.orig/U

flap
{
    type            movingWallVelocity;
    value           uniform (0 0 0);
}
```

```
// Fluid/0.orig/pointDisplacement

flap
{
    type            fixedValue;
    value           $internalField;
}
```

```
// Fluid/constant/dynamicMeshDict

solver      displacementLaplacian;
```

Configure the OpenFOAM adapter

```
// Fluid/system/preciceDict

preciceConfig "precice-config.xml";

participant Fluid;

modules (FSI);

interfaces
{
  Interface1
  {
    mesh                Fluid-Mesh-Centers;
    patches             (flap);
    locations           faceCenters;

    readData
```

Configure the deal.ii adapter

```
// Solid/linear_elasticity.prm

subsection precice configuration
  # Cases: FSI3 or PF for perpendicular flap
  set Scenario             = PF

  # Name of the precice configuration file
  set precice config-file = precice-config.xml

  # Name of the participant in the precice-config.xml file
  set Participant name     = Solid

  # Name of the coupling mesh in the precice-config.xml file
  set Mesh name            = Solid_mesh

  # Name of the read data in the precice-config.xml file
  set Read data name       = Stress
```

Configure preCICE

```
16          <use-data name="Stress"/>
17      </mesh>
18
19      <participant name="Fluid">
20          <use-mesh name="Fluid-Mesh-Nodes" provide="yes"/>
21          <use-mesh name="Fluid-Mesh-Centers" provide="yes"/>
22          <use-mesh name="Solid_mesh" from="Solid"/>
23
24          <read-data name="Displacement" mesh="Fluid-Mesh-Nodes"/>
25          <write-data name="Stress" mesh="Fluid-Mesh-Centers"/>
26
27          <mapping:rbf-thin-plate-splines direction="read"
28              from="Solid_mesh" to="Fluid-Mesh-Nodes"
29              constraint="consistent"/>
30      </participant>
31
32      <participant name="Solid">
```

Configure preCICE

```
16          <use-data name="Stress"/>
17      </mesh>
18
19      <participant name="Fluid">
20          <use-mesh name="Fluid-Mesh-Nodes" provide="yes"/>
21          <use-mesh name="Fluid-Mesh-Centers" provide="yes"/>
22          <use-mesh name="Solid_mesh" from="Solid"/>
23
24          <read-data name="Displacement" mesh="Fluid-Mesh-Nodes"/>
25          <write-data name="Stress" mesh="Fluid-Mesh-Centers"/>
26
27          <mapping:rbf-thin-plate-splines direction="read"
28              from="Solid_mesh" to="Fluid-Mesh-Nodes"
29              constraint="consistent"/>
30      </participant>
31
32      <participant name="Solid">
```

Configure preCICE

```
30      </participant>
31
32      <participant name="Solid">
33          <use-mesh name="Solid_mesh" provide="yes"/>
34          <use-mesh name="Fluid-Mesh-Centers" from="Fluid"/>
35          <use-mesh name="Fluid-Mesh-Nodes" from="Fluid"/>
36
37          <read-data name="Stress"  mesh="Solid_mesh"/>
38          <write-data name="Displacement" mesh="Solid_mesh"/>
39
40          <mapping:rbf-thin-plate-splines direction="read"
41              from="Fluid-Mesh-Centers" to="Solid_mesh"
42              constraint="consistent" />
43
44          <watch-point mesh="Solid_mesh" name="flap_tip"
45              coordinate="-0.05;1;0" />
46      </participant>
47
```

Configure preCICE

```
30      </participant>
31
32      <participant name="Solid">
33          <use-mesh name="Solid_mesh" provide="yes"/>
34          <use-mesh name="Fluid-Mesh-Centers" from="Fluid"/>
35          <use-mesh name="Fluid-Mesh-Nodes" from="Fluid"/>
36
37          <read-data name="Stress"  mesh="Solid_mesh"/>
38          <write-data name="Displacement" mesh="Solid_mesh"/>
39
40          <mapping:rbf-thin-plate-splines direction="read"
41              from="Fluid-Mesh-Centers" to="Solid_mesh"
42              constraint="consistent" />
43
44          <watch-point mesh="Solid_mesh" name="flap_tip"
45              coordinate="-0.05;1;0" />
46      </participant>
47
```

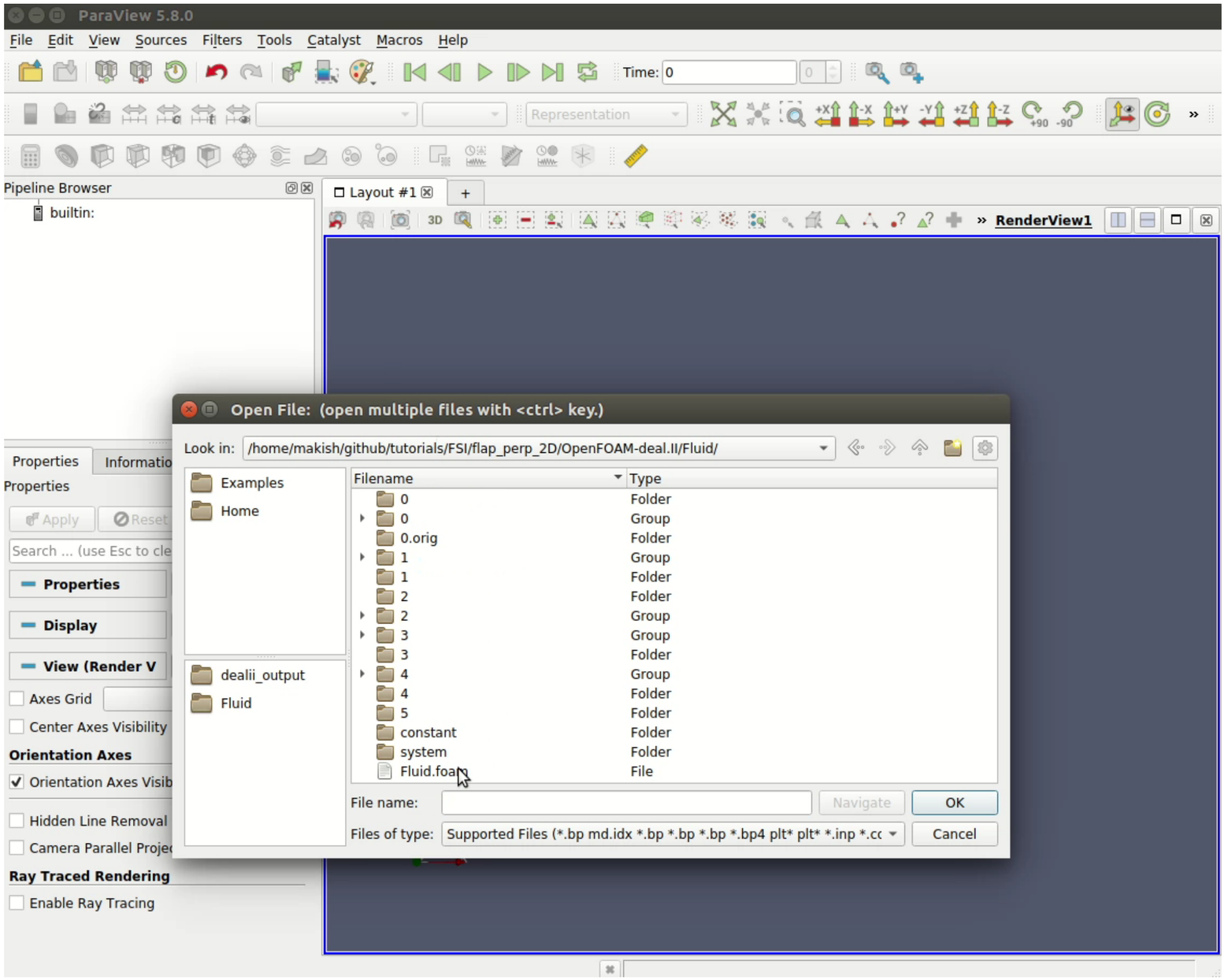
Configure preCICE

```
58
59          <max-iterations value="50"/>
60          <relative-convergence-measure limit="1e-4"
61              data="Stress" mesh="Fluid-Mesh-Centers"/>
62          <relative-convergence-measure limit="1e-4"
63              data="Displacement" mesh="Solid_mesh"/>
64
65          <acceleration:IQN-ILS>
66              <data name="Displacement" mesh="Solid_mesh"/>
67              <preconditioner type="residual-sum"/>
68              <filter type="QR1" limit="1e-6"/>
69              <initial-relaxation value="0.1"/>
70              <max-used-iterations value="50"/>
71              <time-windows-reused value="10"/>
72          </acceleration:IQN-ILS>
73
74      </coupling-scheme:serial-implicit>
75      </solver-interface>
```

```
---[preciceAdapter] [DEBUG]     connectivity : 0
---[preciceAdapter] [DEBUG]     patches      :
---[preciceAdapter] [DEBUG]       - flap
---[preciceAdapter] [DEBUG]     writeData    :
---[preciceAdapter] [DEBUG]       - Forces0
---[preciceAdapter] [DEBUG]     readData     :
---[preciceAdapter] [DEBUG]   - mesh         : Fluid-Mesh-Nodes
---[preciceAdapter] [DEBUG]     locations    : faceNodes
---[preciceAdapter] [DEBUG]     connectivity : 0
---[preciceAdapter] [DEBUG]     patches      :
---[preciceAdapter] [DEBUG]       - flap
---[preciceAdapter] [DEBUG]     writeData    :
---[preciceAdapter] [DEBUG]     readData     :
---[preciceAdapter] [DEBUG]       - Displacements0
---[preciceAdapter] [DEBUG] Configuring the FSI module...
---[preciceAdapter] [DEBUG]     user-defined solver type :
---[preciceAdapter] [DEBUG]     pointDisplacement field name : pointDisplacem
ent
---[preciceAdapter] [DEBUG] Unknown solver type. Determining the solver type.
..
---[preciceAdapter] [DEBUG] Automatically determined solver type : incompress
ible
---[preciceAdapter] [DEBUG] Checking the timestep type (fixed vs adjustabl
..
---[preciceAdapter] [DEBUG]   Timestep type: fixed.
---[preciceAdapter] [DEBUG] Creating the preCICE solver interface...
---[preciceAdapter] [DEBUG]   Number of processes: 1
---[preciceAdapter] [DEBUG]   MPI rank: 0
---[precice]  This is preCICE version 2.0.2
---[precice]  Revision info: v2.0.2
---[precice]  Configuring preCICE with configuration: "precice-config.xml"
---[preciceAdapter] [DEBUG]   preCICE solver interface was created.
---[preciceAdapter] [DEBUG] Creating interfaces...
---[preciceAdapter] [DEBUG] Number of face centres: 33
---[preciceAdapter] [DEBUG] Interface created on mesh Fluid-Mesh-Faces
---[preciceAdapter] [DEBUG] Adding coupling data writers...
---[preciceAdapter] [DEBUG] Added writer: Force.
---[preciceAdapter] [DEBUG] Adding coupling data readers...
---[preciceAdapter] [DEBUG] Number of face nodes: 68
---[preciceAdapter] [DEBUG] Interface created on mesh Fluid-Mesh-Nodes
---[preciceAdapter] [DEBUG] Adding coupling data writers...
---[preciceAdapter] [DEBUG] Adding coupling data readers...
---[preciceAdapter] [DEBUG] Added reader: Displacement.
---[preciceAdapter] [DEBUG] Initalizing the preCICE solver interface...
---[precice]  Setting up master communication to coupling partner/s
```

```
(base) ~/git/hub/tutorials/FSI/flap_perp/OpenFOAM-CalculiX/Solid [master]$ ls
flap.12d  flap.inp  mesh.sh  post_flap.fbd  pre_flap.fbd
(base) ~/git/hub/tutorials/FSI/flap_perp/OpenFOAM-CalculiX/Solid [master]$ cg
x -bg pre_flap.fbd
on a Linux machine, nodename Magdalena, release 4.15.0-106-generic, version #
107~16.04.1-Ubuntu SMP Thu Jun 4 15:40:05 UTC 2020, machine x86_64
parameters:3 arguments:2

pre_flap.fbd opened
 reading file
 #!/bin/bash
 #For the beam elements
 please wait for 'ready'
 makeSurfaces
 getElemNormalen
 realloc_colNr
 add the faces
 updateDispLists
 delSet
 ready
 please wait for 'ready'
 write abaqus data
 file all.msh opened
 ready
 please wait for 'ready'
 write file: fix1.nam
 ready
 ready
 please wait for 'ready'
 write file: surface.nam
 ready
 ready
 # #rot z
 #rot r 50
 #rot u 50
 # Add thing here for the boundary condition
 # sys echo
 # quit
 # plus la all
 # plus pa all
 done

(base) ~/git/hub/tutorials/FSI/flap_perp/OpenFOAM-CalculiX/Solid [master]$ cd
 ..
(base) ~/git/hub/tutorials/FSI/flap_perp/OpenFOAM-CalculiX [master]$ ccx_preC
ICE -i Solid/flap -precice-participant Calculix
```

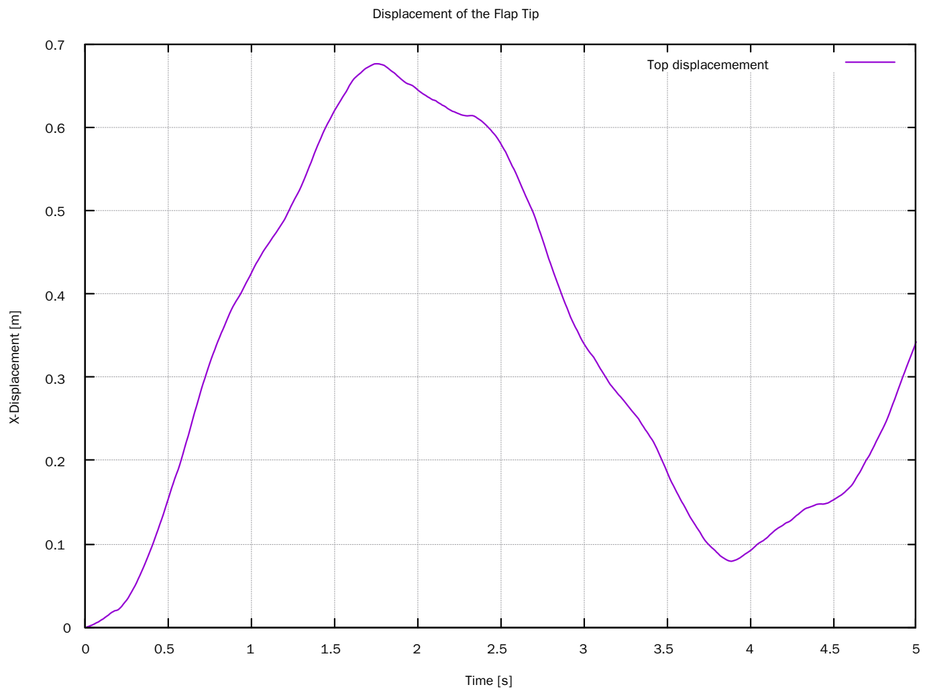
```
[10] 0:bash*                                                    "Magdalena" 09:22 22-Jun-20
```



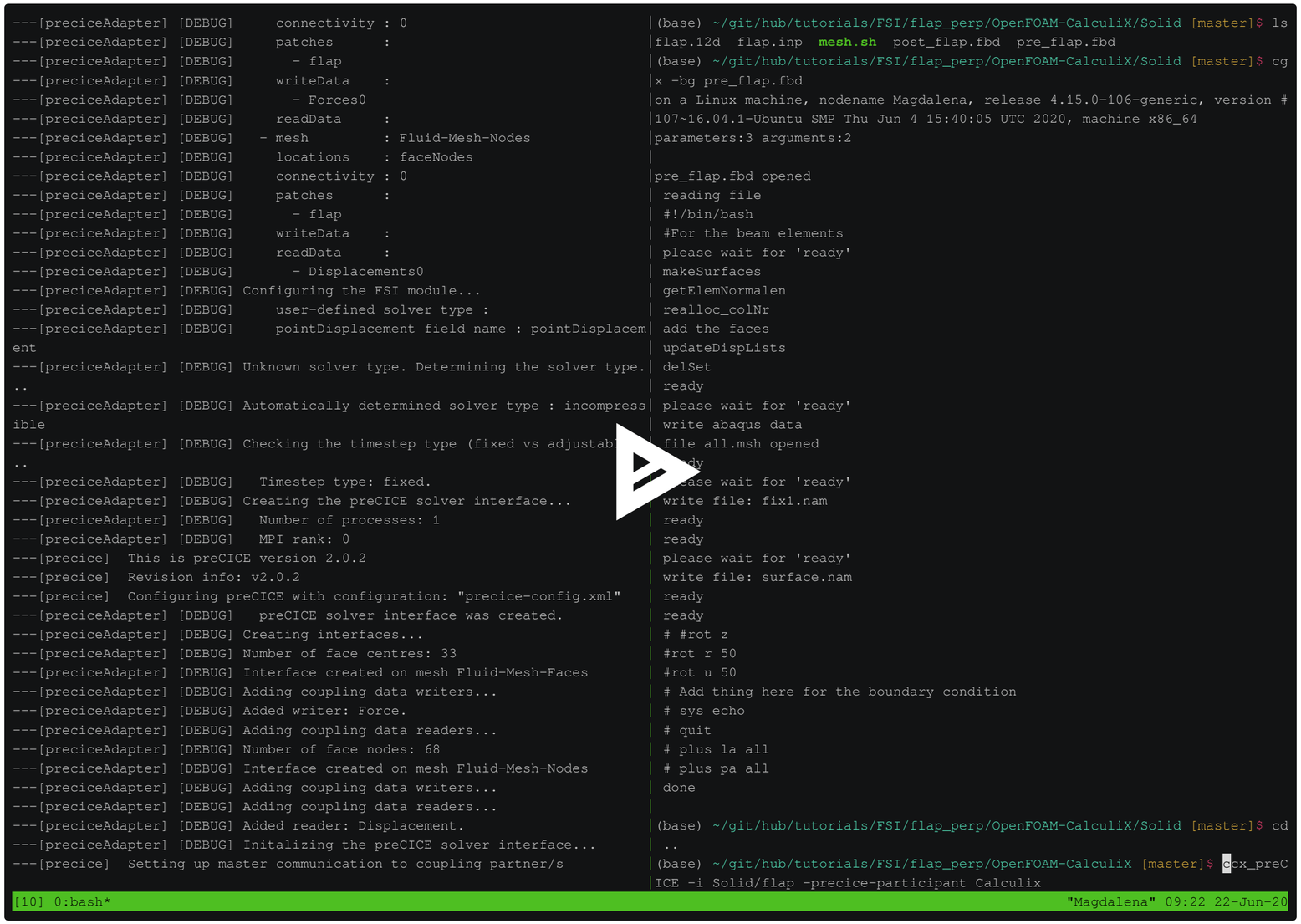
Linear solid model

How is the tip moving?

```
#! /bin/bash
gnuplot -p << EOF
set grid
set title 'Displacement of the Flap Tip'
set xlabel 'Time [s]'
set ylabel 'X-Displacement [m]'
set linestyle  1 lt 2 lc 1 # red-dashed
plot "precice-Solid-watchpoint-flap_tip.
     using 1:4
     title 'Top displacemement'
     with lines
EOF
```



See also: OpenFOAM + CalculiX



Resources

Start here: precice.org

Welcome to preCICE

News: preCICE release v2.0.2 available since Apr 3, 2020

Now also on YouTube: Subscribe to our new YouTube channel, where you can also find the talks from the preCICE Workshop 2020.

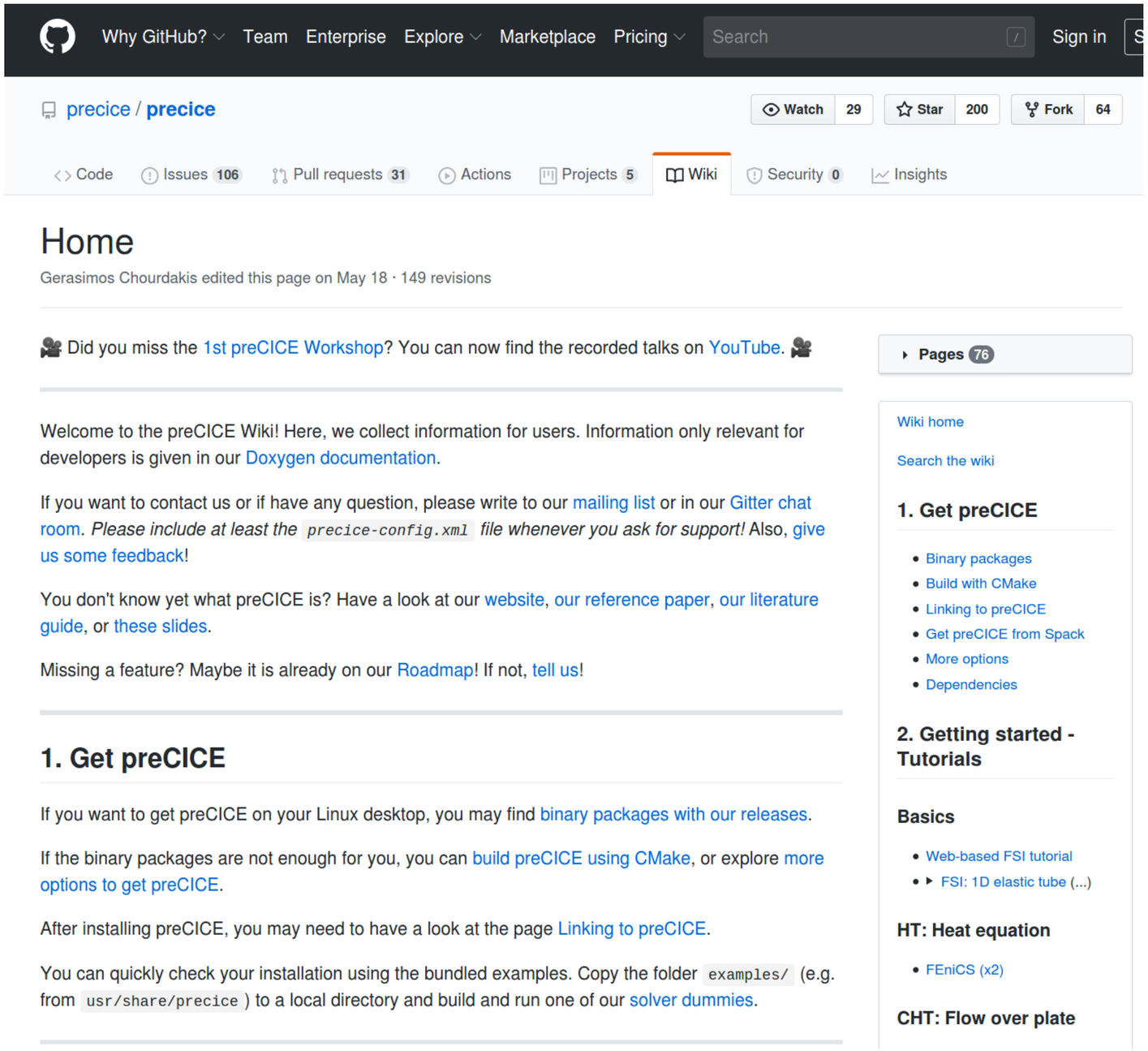
preCICE in xSDK: preCICE is now part of the xSDK framework. Read the compatibility policies…

preCICE (Precise Code Interaction Coupling Environment) is a coupling library for partitioned multi-physics simulations, including, but not restricted to fluid-structure interaction and conjugate heat transfer simulations. Partitioned means that preCICE couples existing programs (solvers) capable of simulating a subpart of the complete physics involved in a simulation. This allows for the high flexibility that is needed to keep a decent time-to-solution for complex multi-physics scenarios. preCICE runs efficiently on a wide spectrum of systems, from low-end workstations up to complete compute clusters and has proven scalability on 10000s of MPI Ranks.

The software offers methods for transient equation coupling, communication means, and data mapping schemes. preCICE is written in C++ and offers additional bindings for C, Fortran, Matlab, and Python. Ready-to-use adapters for well-known commercial and open-source solvers, such as OpenFOAM, deal.II, FEniCS, SU2, or CalculiX, are available. Due to the minimally-invasive approach of preCICE, adapters for in-house codes can be implemented and validated in only a few weeks.

preCICE is an open-source software under the LGPL3 license and available on GitHub.

Documentation



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preCICE

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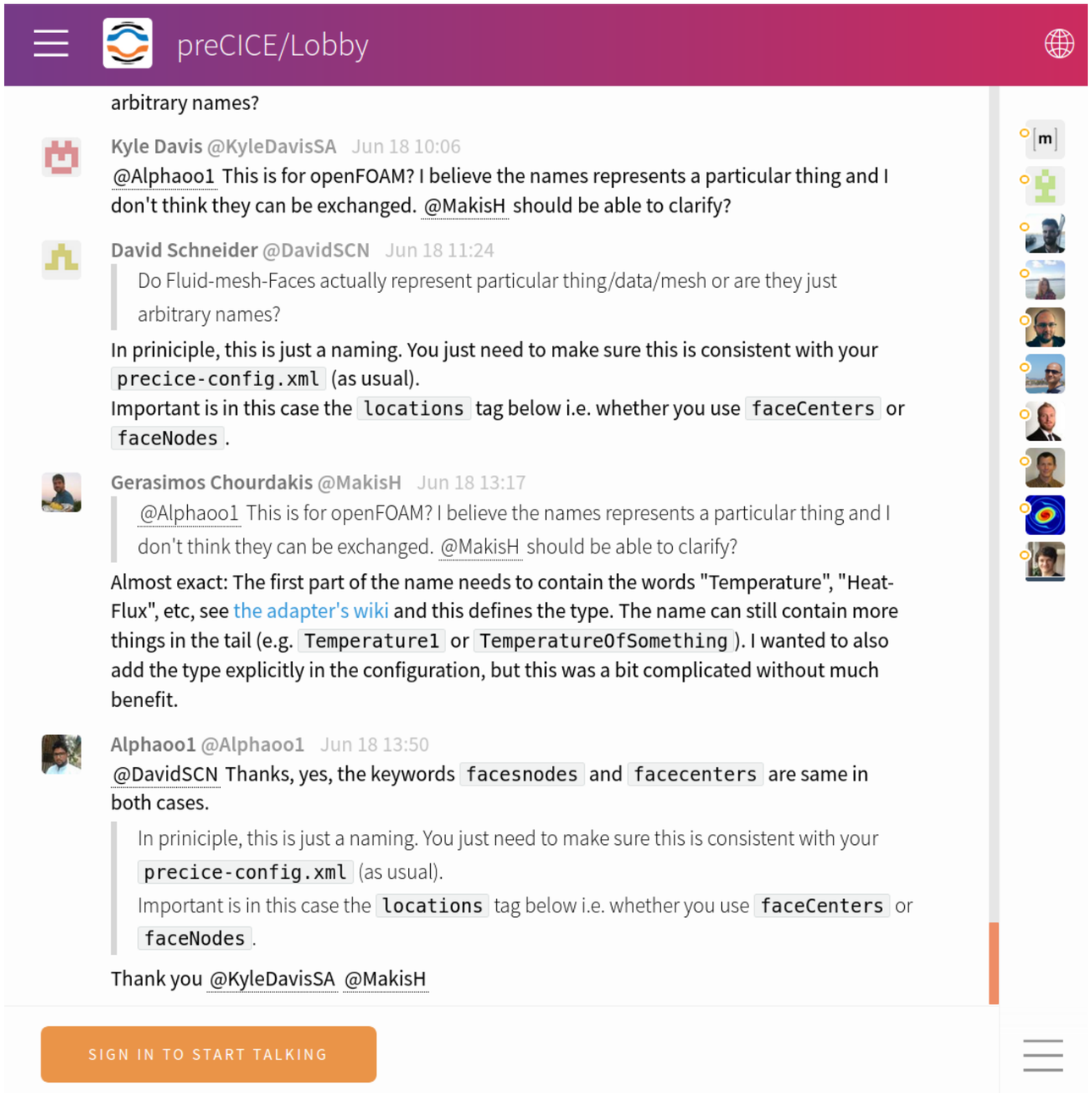
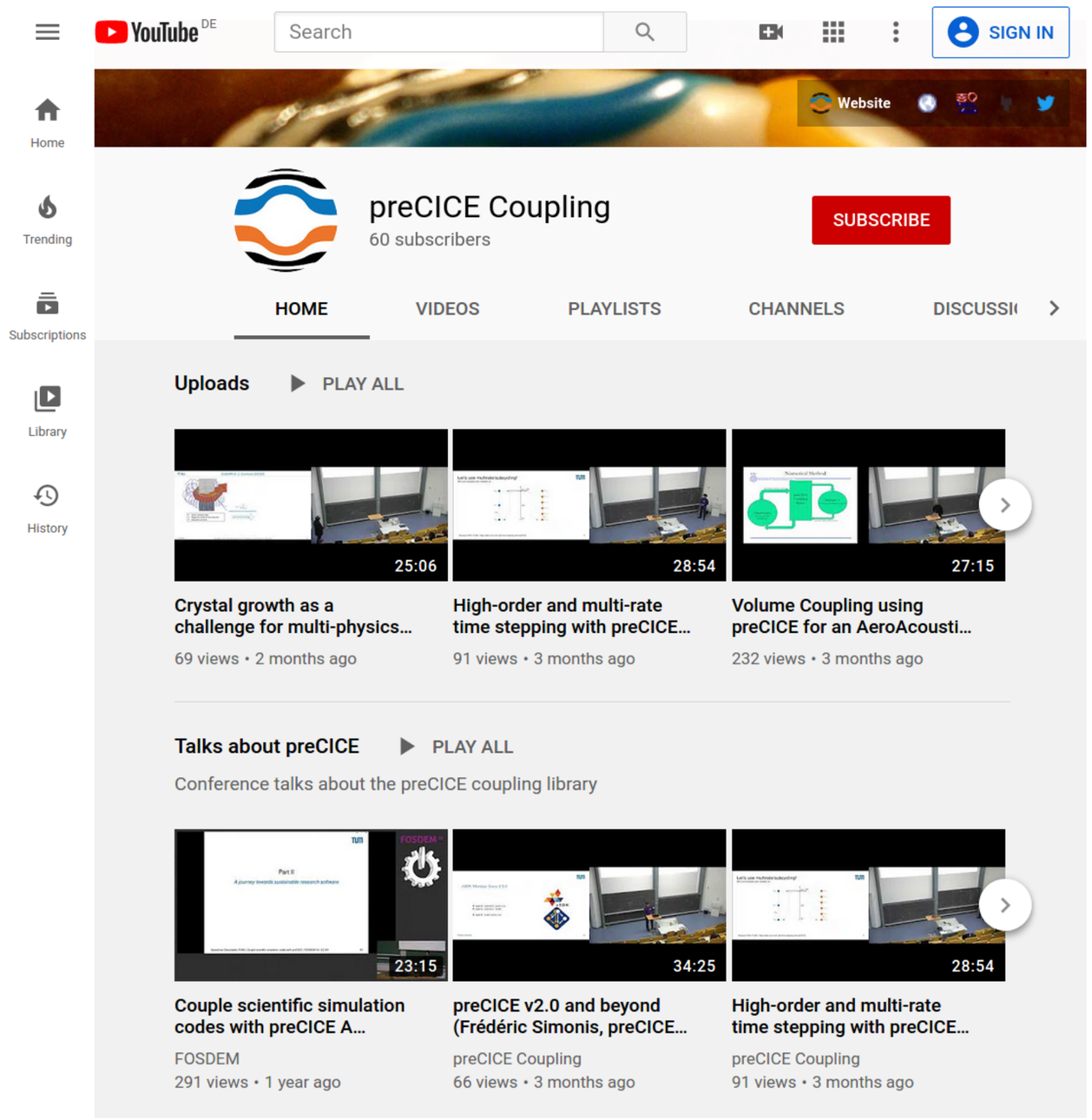
	Assertion failed on ResidualSumPreconditioner Using preCICE	3 9d
	RBF mapping vs. nearest projection mapping Using preCICE openfoam data-mapping calculix fsi	3 14d

Discuss & get help (quick)



Learn: YouTube



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A free/open-source coupling library for partitioned multi-physics simulations, including fluid-structure interaction, conjugate heat transfer, and more.

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preCICE -- preCICE Parallel Coupling Environment

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preCICE Workshop 2021

preCICE Workshop 2020 @ TUM

preCICE is free because of

H2020 grant 754462

and the code/issues/testing/documentation contributions of people like you (thank you!).

Summary

Easily exchange your coupled solvers and explore advanced & performant numerical algorithms

Gerasimos Chourdakis (TUM)
Benjamin Uekermann (TU/e)
+ many more (see precice.org/about)

Start a thread on our forum

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