Parallelism in IC-Ferst

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Parallel Simulations

- Modern computers process calculations faster by dividing operations into separate jobs solved concurrently ("in parallel") by multiple processing units.

    - Multiple paradyms:
        - Distributed memory : each job (process) on its own "computer". Need to communicate information across network.
        - Shared memory : Many workers (threads), but a single copy of data. Need to control access to resources.

    - IC-Ferst runs in parallel via MPI (distributed memory)
    - Future: OpenMP threading for shared memory runs.

Parallelism: An example

Now for a short example of the advantages and pitfalls of a distributed computing job:

- ▶ Can I have 3 volunteers from the audience please?

Parallelism: An example

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Process One, please answer the questions on the next slide as fast as you can:

Parallelism: An example

▶ Can I have 3 volunteers from the audience please?

Process One, please answer the questions on this slide as fast as you can:

Process One:

1. What's your (real) name?
2. What is $3 + 4$?
3. What is 2×7?
4. What is $12 \div 2$?
5. What's your favourite animal?

Parallelism: An example

Processes One, Two & Three please answer your questions on the next slide as fast as you can:

 Process One: Process Two: Process Three:

Parallelism: An example

Processes One, Two & Three please answer your questions on this slide as fast as you can:

Process One:

1. What's your name?
2. What is $2 + 3$?
3. What is 4×3?
4. What's your favourite colour?
5. What's Process Three's favourite colour?

Process Two:

1. What's your name?
2. What is $7 - 6$?
3. What's your favourite colour?
4. What's Process One's favourite colour?

Process Three:

1. What's your name?
2. What is $2 + 9$?
3. What is $9 \div 3$?
4. What's your favourite colour?
5. What's Process Two's favourite colour?

Parallel Simulations

- How to run IC-Ferst in parallel:

  - No changes to the .mpml required!
    - Parallel compatible preconditioner (not eisenstat or lu)
    - Optional: Remove unwanted fields from output (.stat and .vtu)

  - Need to decompose the mesh
    - Tools provided: `fldecomp`
    - Build with: `make fltools`
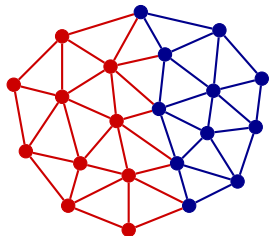
Mesh decomposition

- Mesh decomposition before the run:

  - `fldecomp -n 4 -m gmsh mesh_name`
    - Decomposes mesh named `mesh_name.msh`

  - Now run this on 4 processors:
    `mpiexec -n 4 multiphase_prototype my_cool_simulation.mpml`

  - Outputs in new format, `.pvtu`, which can be read by Paraview.