Lowering the Barriers to In-Situ Visualization

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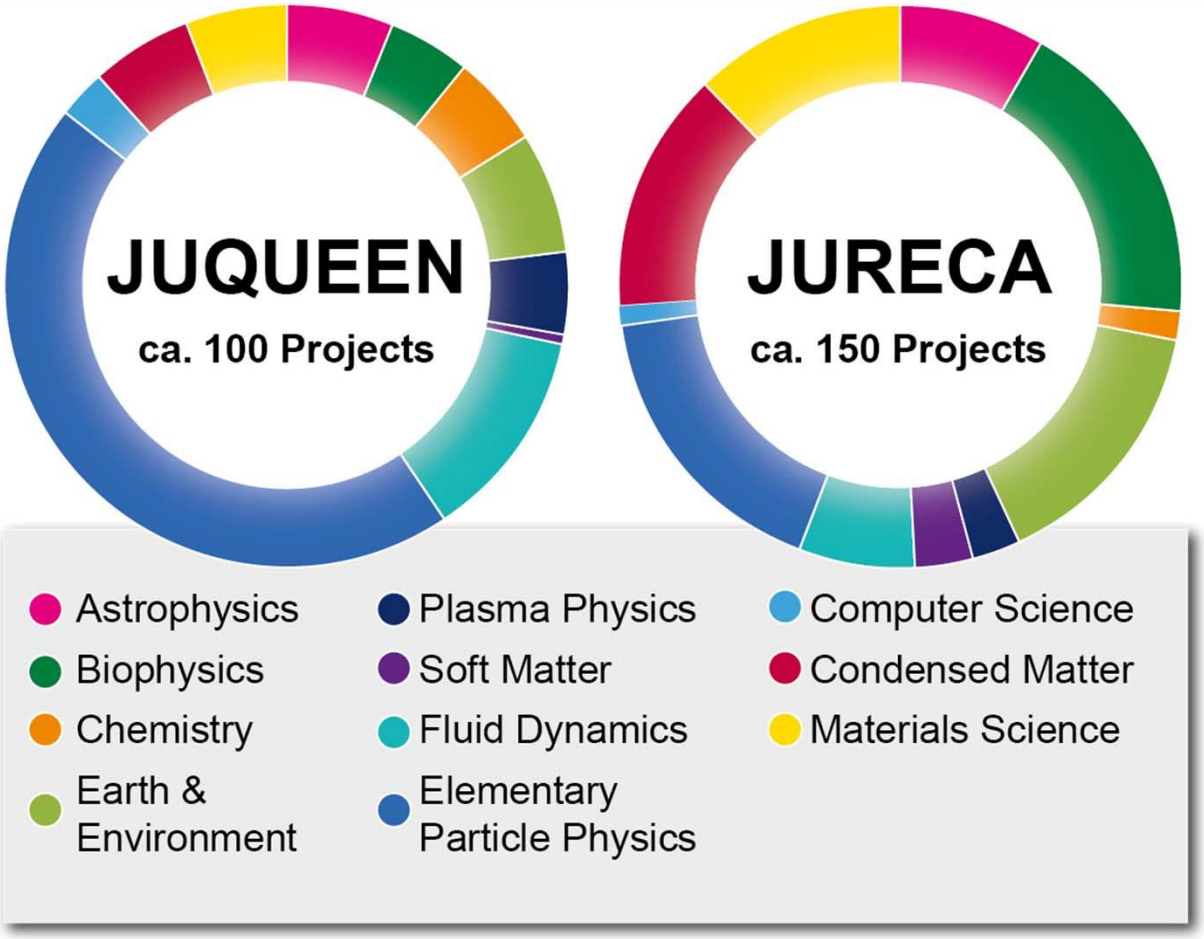
Motivation

lowering the barriers to in-situ visualization



Granting periods: 05/2015 – 04/2016, 11/2014 – 10/2015

Motivation

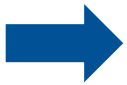
lowering the barriers to in-situ visualization

… first,

- the individual implementation-, optimization- and coupling-costs to integrate the needed functionality to each simulation code and setup can often not be justified.

… second,

- the usage of in-situ visualization requires much training for scientists who's research work does not focus on visualization in the first place.



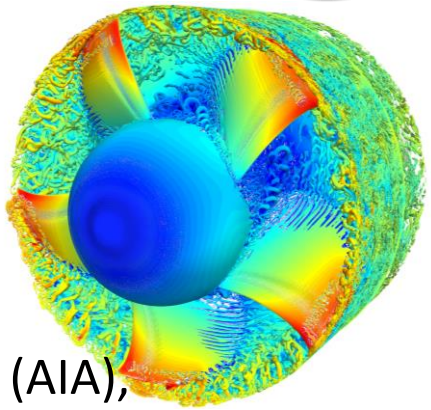
Lowering the barriers to in-situ visualization

Applications

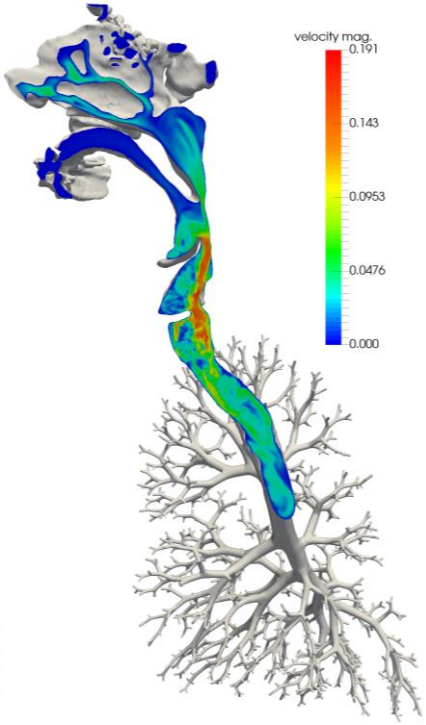
ZFS – zonal flow solver

... ZFS

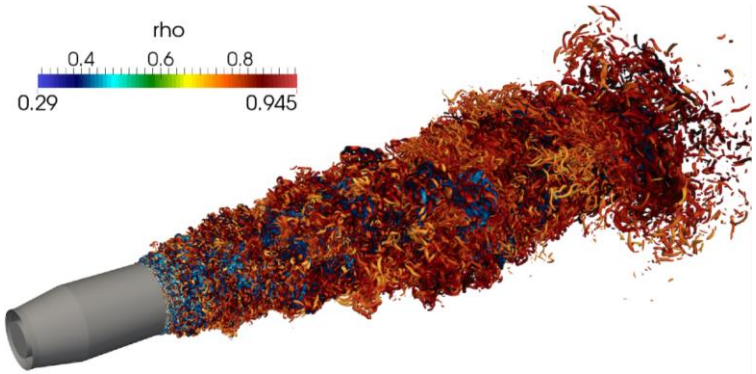
- flow solver
- finite volume method
- Lattice-Boltzmann method
- Institute of Aerodynamics Aachen (AIA), RWTH Aachen University
- C++11 + MPI



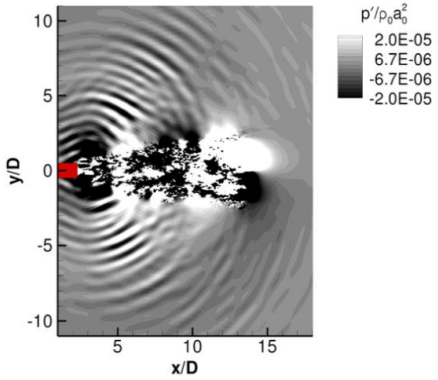
turbulent flow around an axial fan (FVM), AIA



flow in the human respiratory tract (LBM), SLFSE



turbulent engine jet (FVM), AIA



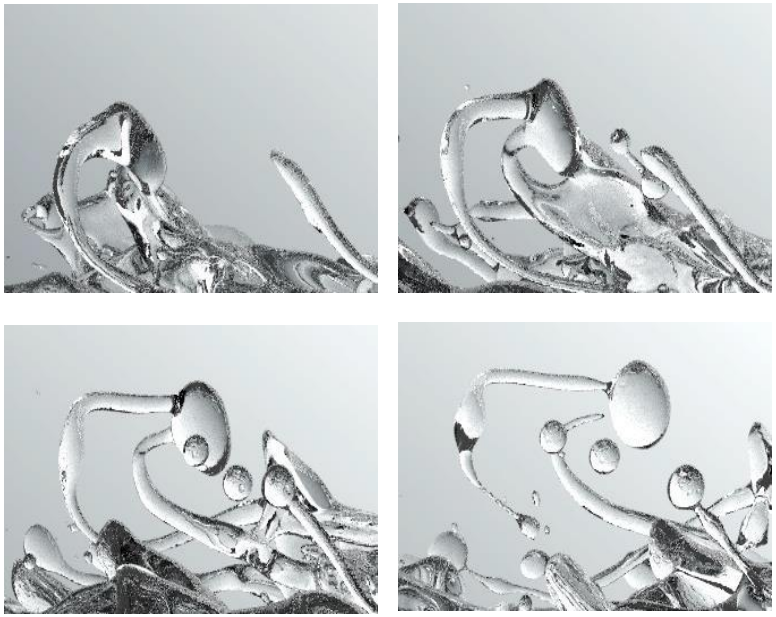
acoustic pressure fluctuations of a turbulent jet (DG), AIA, SLFSE

Applications

CIAO – multiphysics solver

… CIAO

- multiphysics, multiscale Navier-Stokes solver (LES and DNS) for turbulent reacting flows in complex geometries
- structured finite difference
- Institute for Combustion Technology (ITV), RWTH Aachen University
- Fortran90 + MPI

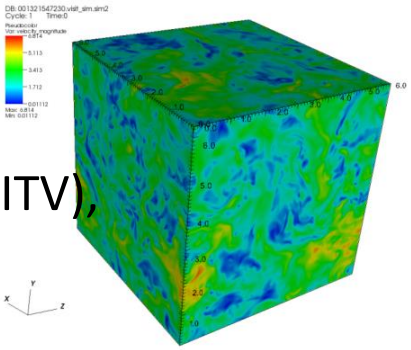


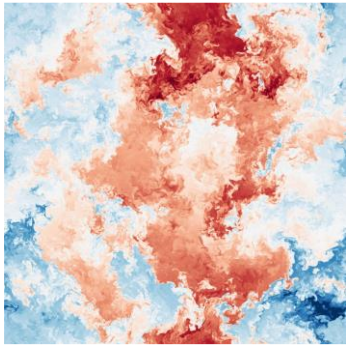
Applications

psOpen – pseudo-spectral solver

... psOpen

- Direct Numerical Simulation (DNS)
- pseudo-spectral approach
- Institute for Combustion Technology (ITV), RWTH Aachen University
- Fortran90 + MPI/OpenMP





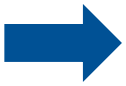
	R0	R1	R2	R3	R4	R5	R6
N^3	512^3	1024^3	1024^3	2048^3	2048^3	4096^3	4096^3
Re_λ	88	119	184	215	331	529	754
file size (GB)	8	64	64	512	512	4096	4096
M	189	62	61	10	10	6	11
data size (TB)	1.5	3.88	3.81	5	5	24	44

JUSITU

coupling simulation code to in-situ visualization

- light-weighted, flexible and easy-to-use coupling library
- covers the complexity and numerous options of in-situ visualization
- supported in-situ framework
  - VisIt/Libsim, ParaView/Catalyst
- rewritten in C++ (initially started for psOpen in Fortran90)
- 3 sim. codes instrumented, 2 sim. codes working on

- lowers the barriers to integrate visualization techniques into an existing simulation code
- simplify cooperation between simulation code developers and visualization code developers



Get first results as quickly as possible!

JUSITU

coupling simulation code to in-situ visualization

… 1. creating a data adaptor

VTK data adapter =>

a) VisIt/Libsim callback functions

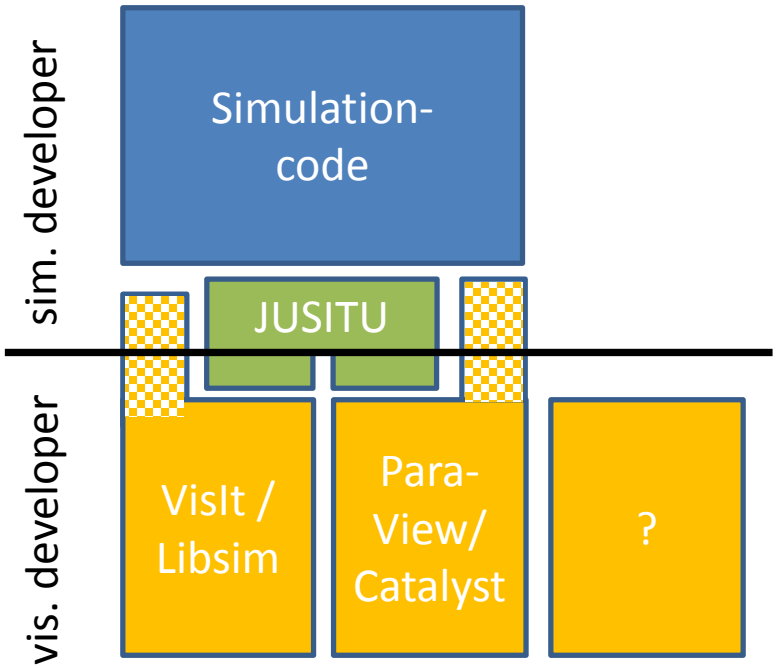
b) ParaView/Catalyst data adapter

… 2. adding in-situ capability to simulation code

```
do {
    // update simulation
    sim->iterate();

    // check for visualization input
    vis->checkStatus( sim->getILoop(), sim->getITime() );

} while(true);
```



Why should this simplify integration of in-situ visualization?

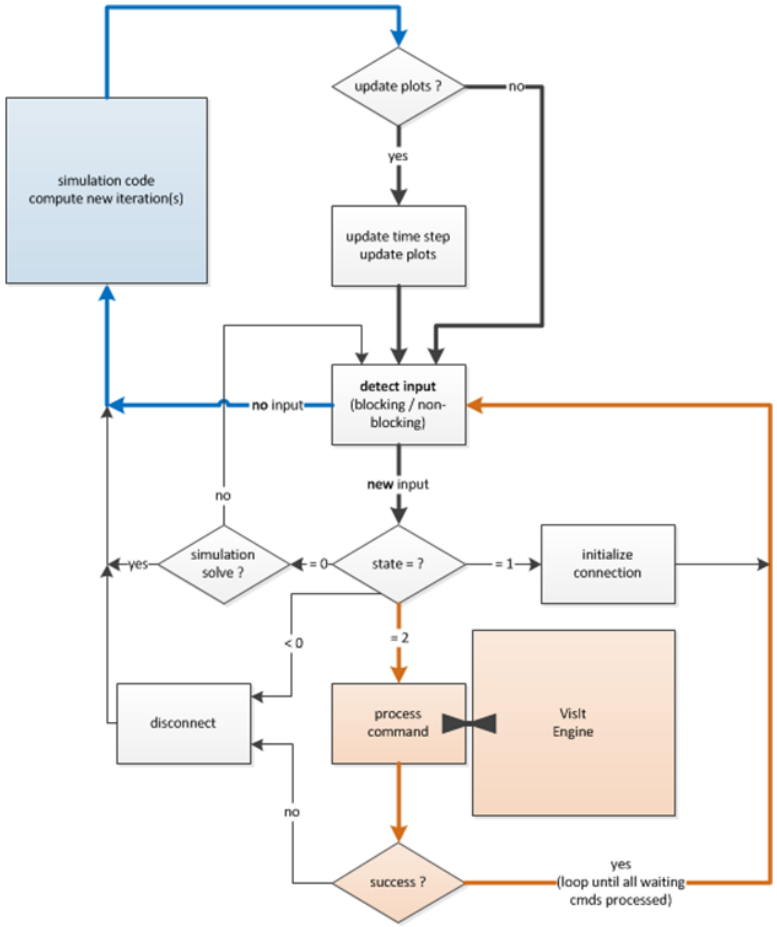
Example …?

JUSITU

coupling simulation code to VisIt/Libsim

... common commands

- run sim. + never update vis.
- run sim. + always update vis.
- pause sim. + run vis.
- step sim. + step vis.



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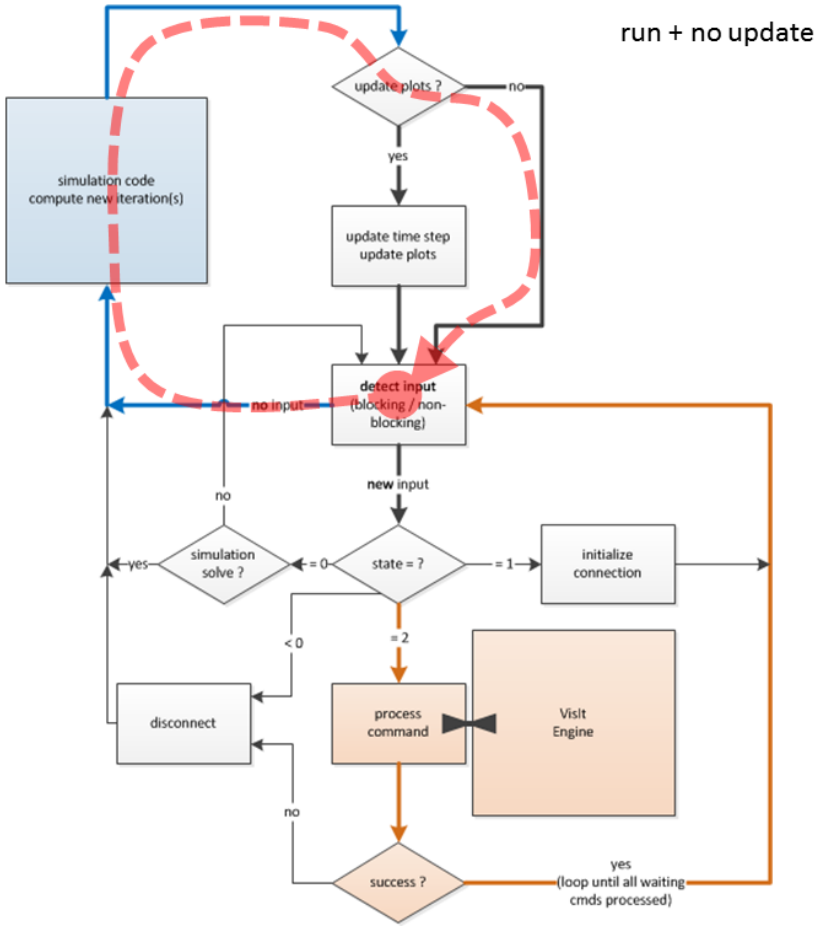

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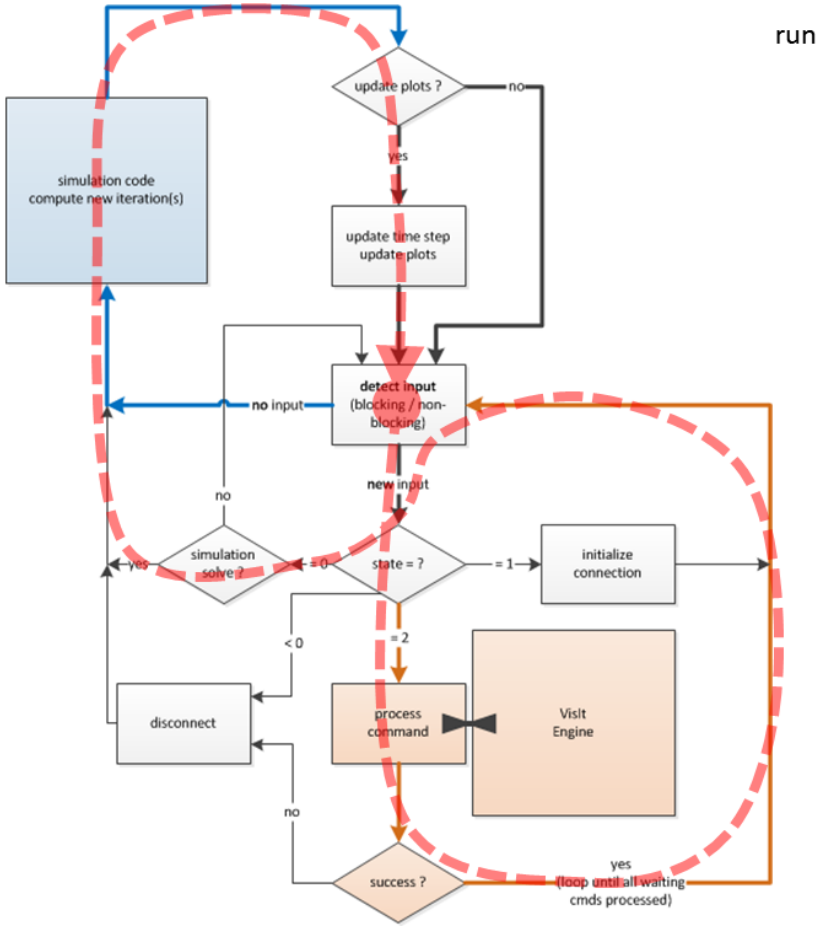

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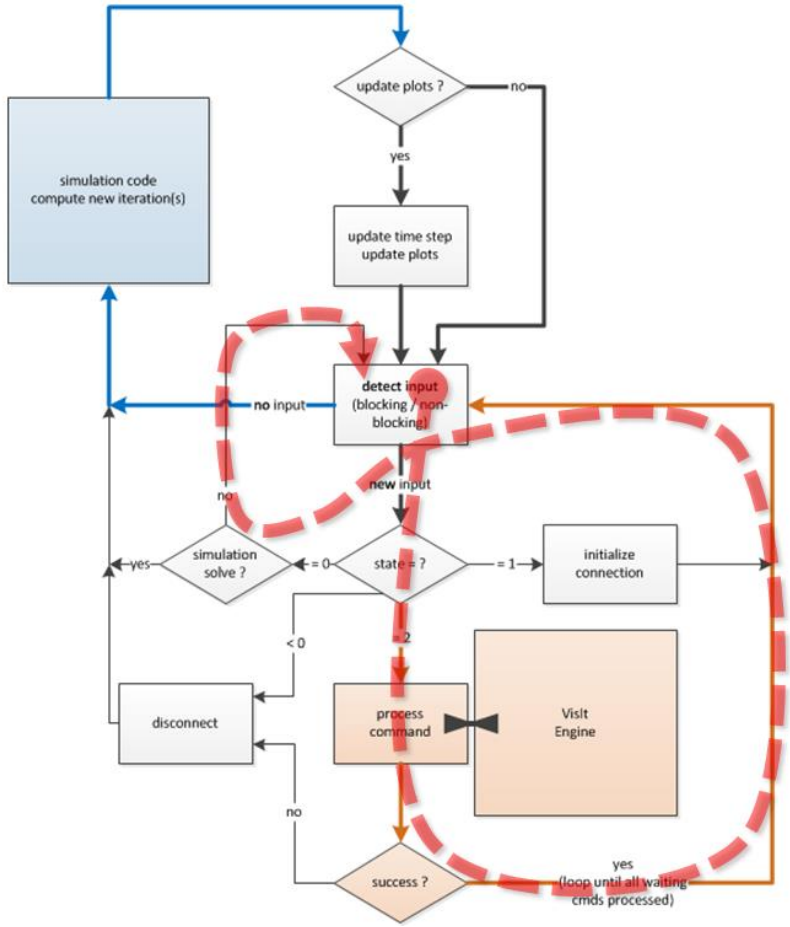

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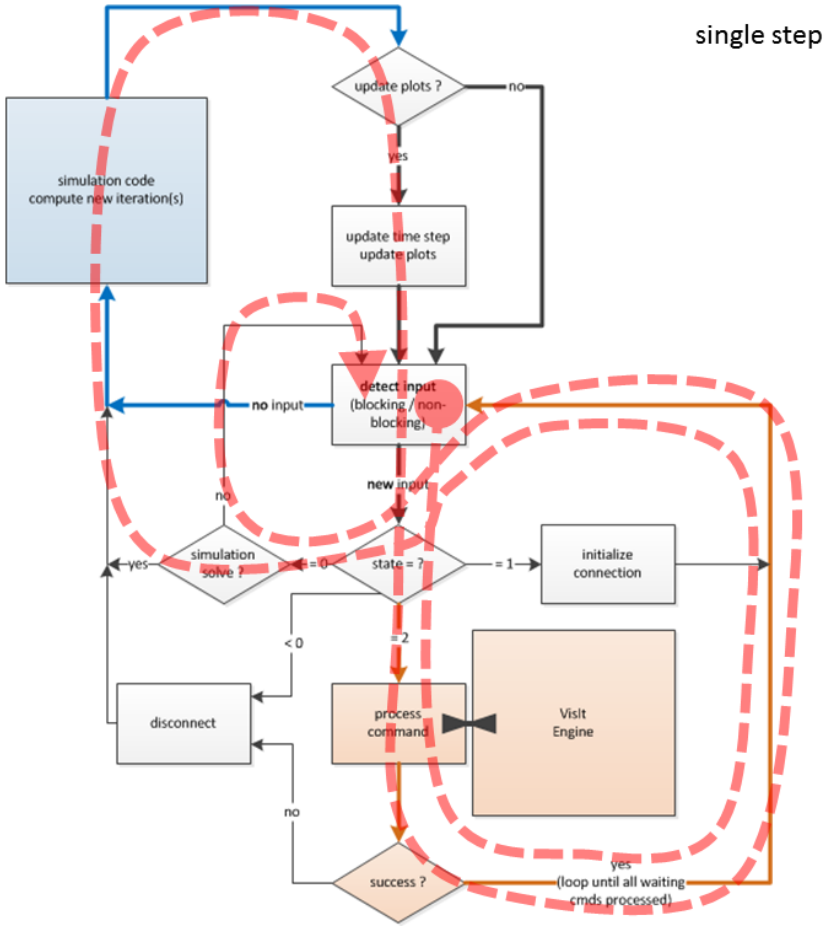

JUSITU

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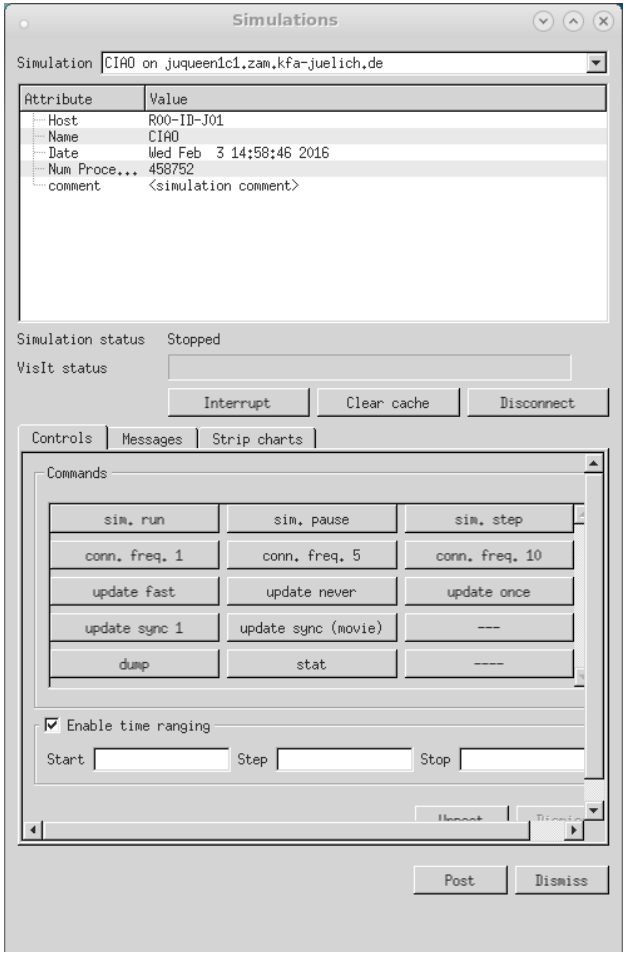
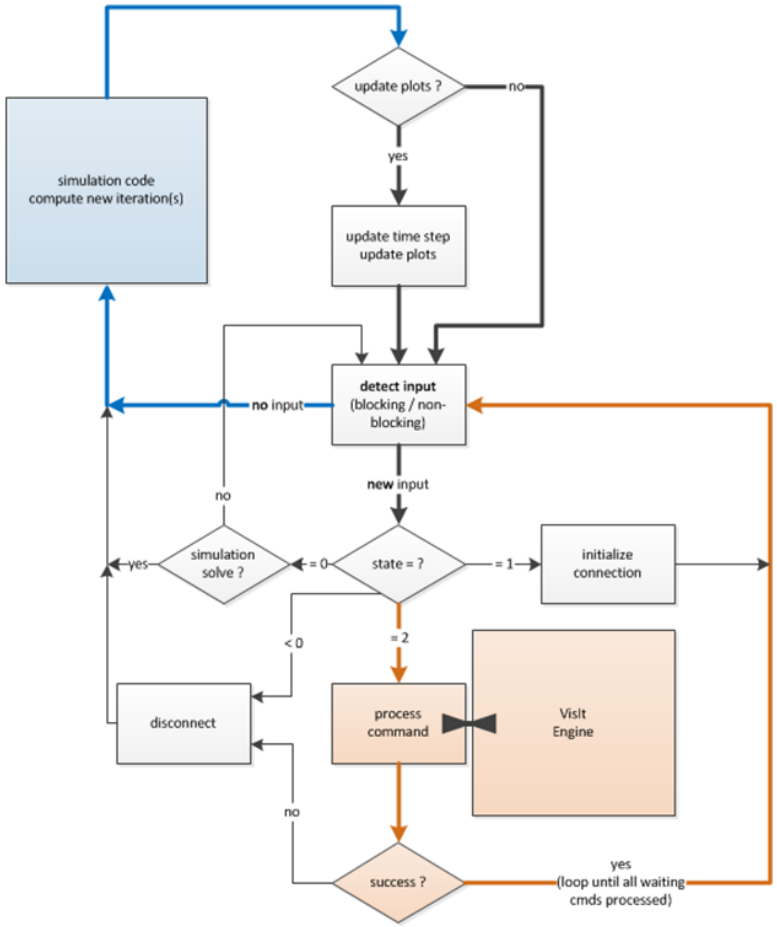
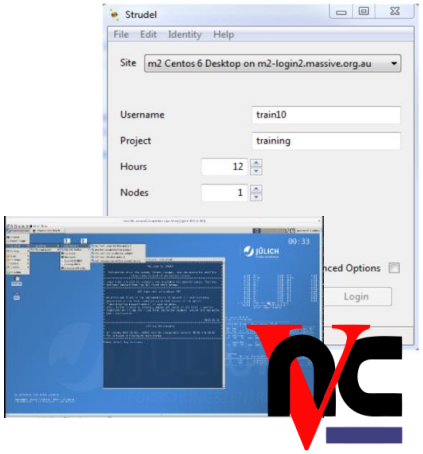
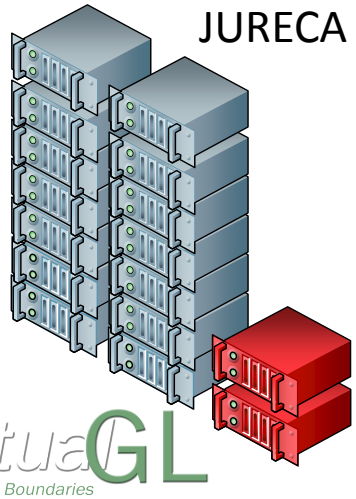


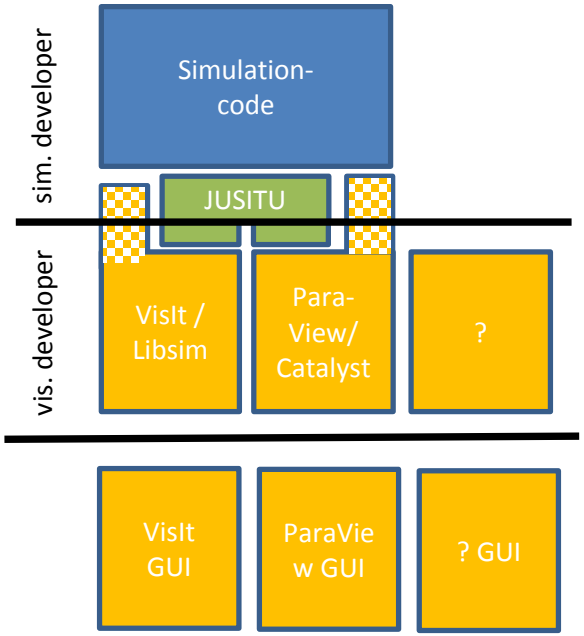


Usage of In-Situ Visualization

importance of remote visualization desktops







... easy access to remote visualization desktops

- ScienTific Remote Desktop Launcher (Strudel)

  Multi-modal Australian ScienceS Imaging and Visualisation Enviroment (MASSIVE)
- XDG profiles for different desktop setups

Visualization tools should be setup, configured and ready to use.

Summary & Conclusion

- A huge number of simulation codes and scientists could benefit from in-situ visualization, but **spending much time to implement it can often not be justified**.
- JUSITU **simplifies the integration** of in-situ visualization into existing simulation code and allows to switch between different visualization tools.
- Beside the integration it is of importance to simplify the everyday use of in-situ visualization. **Easy access to remote visualization desktops** is of high importance.

Thank you for your attention.
Questions ?