PYPHIA: the parallel software platform for fluid dynamics simulations with an efficient load balancing algorithm

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Computational fluid dynamics (CFD) is one of the main research tools in science and engineering, which consumes a significant part of computational resources nowadays. Modern supercomputers allow to achieve a very high spatial resolution: billions of mesh cells may be distributed between computing nodes. However, the software implementation of various numerical schemes is dramatically complicated for heterogeneous clusters, where several kinds of computing units should be used simultaneously. Moreover, such parallel algorithms are usually designed for a particular numerical method and cannot be directly applied to another one.

The developed parallel software platform PYPHIA provides an ability to use the unified parallel algorithms for numerical methods, which were considered inconsistent. For example, one may apply the Voronoi Dynamic Domain Decomposition (VD^3) algorithm [1] for parallel simulations with finite volume method, finite elements method, or smoothed particle hydrodynamics. The simultaneous modelling using these methods in different regions of space with appropriate coupling interfaces may incorporate advantages of the methods and open a new area of applied problems to solve.

[1] Egorova M S, Dyachkov S A, Parshikov A N and Zhakhovsky V V 2019 *Computer Physics Communications* **234** 112–125