Description For The General Public (In English) (State the objective of the project, describe the basic research to be carried out, and present reasons for choosing the research topic - max. 2 standard type-written pages)

Numerical modelling based on the digital material representation idea, which introduces microstructure elements in a direct manner (grains, grains boundaries, inclusions, particles, phase boundaries, etc.), is being rapidly developed in the leading scientific centers. Simulations based on this approach give opportunity to analyzed material behavior under conditions, which were not possible to monitor in the conventional approaches where microstructure was treated as a homogeneous material. The digital material representation concept combined with the discrete modelling techniques e.g. cellular automata (CA) provide opportunity to perform material evolution simulations during various metalforming and heat treatment operations. This kind of simulation is a powerful computational tool because it allows control of many aspects of material microstructure evolution during various metalforming processes. **A lot of publications dedicated to simulation based on this approach can be found in the scientific literature, but the major problem of these models lies in the high computational cost, which is a limiting factor in practical application during designing of new metalforming technologies. Thus, presently, application of the approach at industrial scale is practically impossible and is limited only to scientific investigations.** However, there are two approaches that can minimize CA model computational complexity and simulation time. First, is based on frontal cellular automata concept, which assumes that computations are realized only in selected areas of the investigated microstructure e.g. at the grain boundaries. The second approach takes advantages of modern computer centers that can additionally work in the grid environment. They are equipped with hundred and sometimes even thousands of computational units, providing enormous computational power. **In the current project authors decided to use second approach based on the parallel and distributed computing concept to minimize computational time of the CA models.** However, the latter approach, requires a series of fundamental research related to redesigning of the CA algorithms in order to take advantages of mentioned computing power. New algorithms dedicated for high-performance computing including: communication and synchronization protocols both for logical and physical computing units have to be developed and their behavior in detail investigated (Figure 1). Without that, even with high computing power the simulation time will not decrease.

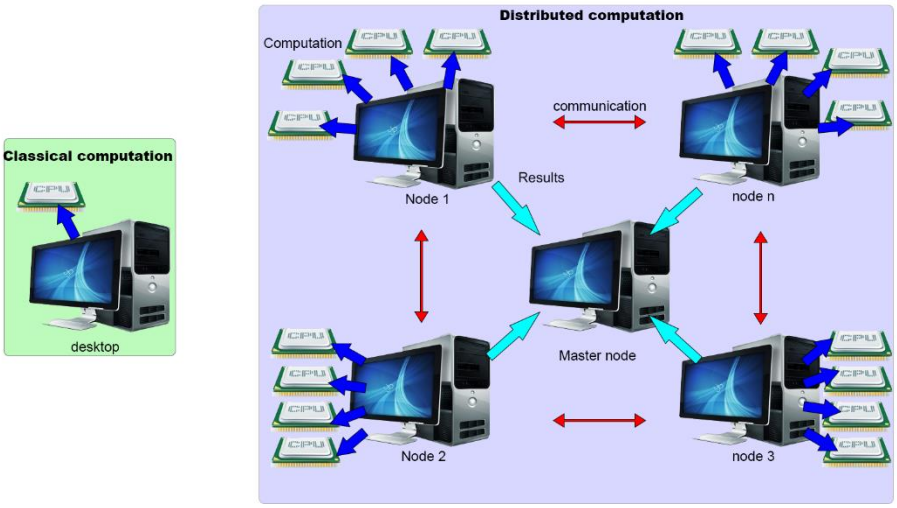

Figure 1. The idea of classical and distributed computing.

Parallel and distributed computations can be performed on two types of computing units: multi-core processors or computing clusters working in the grid environment (e.g. PLGrid with 3,642 GFlops computational power and more than 2,25 PB of memory). During current project authors will focus on utilization of distributed/grid platform during CA simulations of microstructure evolution. Development of parallel model of static recrystallization in austenitic steel was selected within the project as a case study. The conventional sequential version of most important algorithms has already been developed during the preparatory work for the project, thus it will be the foundation for the present research. Eventually, computationally efficient CA models will provide in the near future possibility to support industrial processes with online simulations, performed during manufacturing cycle, and will give an immediate adjustment of process conditions to precisely control final product properties.