Optimizing Biomedical Ultrasound Workflow Scheduling Using Cluster Simulations

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Abstract. Therapeutic ultrasound plays an increasing role in dealing with oncological diseases, drug delivery and neurostimulations. To optimize its benefits, the treatment procedures must be adapted carefully to patients needs. For this purpose, complex physical models have to be evaluated prior to the treatment to tailor parameters and estimate the outcomes of the treatment. Typically, for each patient a workflow consisting of several (dependent) tasks and simulations has to be performed before proceeding to the actual therapy. Such workflows require large parallel infrastructure, e.g., a computing cluster or a cloud to be processed in an acceptable time. Since these resources are expensive, scheduling plays an important part in the whole process. Its goal is to assign proper computational resources to particular tasks in order to efficiently use the available infrastructure. Typically, maximizing the utilization and minimizing the total execution time (makespan) and cost are the optimization goals. In this paper, we describe the problems related to scheduling tasks in the k-Dispatch workflow management system that is designed to orchestrate execution of ultrasound simulations for clinical purposes. Importantly, we provide real life-based problem description and present an extension of an existing job scheduling simulator that allows to easily model and evaluate various setups of workflow and system parameters, thus simplifying the decision process of selecting proper ultrasound simulation parameters.

Keywords: scheduling, workflow, ultrasound, k-Dispatch, simulation