DDM APPLIED TO SUBSURFACE FLOW AND TRANSPORT

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Abstract

Mathematical models of many systems of interest, including very important continuous systems of Earth Sciences and Engineering, lead to a great variety of partial differential equations (PDEs) whose solution methods are based on the computational processing of large-scale algebraic systems. Furthermore, the incredible expansion experienced by the existing computational hardware and software has made amenable to effective treatment problems of an ever increasing diversity and complexity, posed by scientific and engineering applications.

Parallel computing is outstanding among the new computational tools and, in order to effectively use the most advanced computers available today, massively parallel software is required. Domain decomposition methods (DDMs) have been developed precisely for effectively treating PDEs in parallel. Ideally, the main objective of domain decomposition research is to produce algorithms capable of *'obtaining the global solution by exclusively solving local problems'*, but up-to-now this has only been an aspiration; that is, a strong desire for achieving such a property and so we call it *'the DDM-paradigm'*. In recent times, numerically competitive DDM-algorithms are *non-overlapping*, *preconditioned* and necessarily incorporate *constraints* which pose an additional challenge for achieving the *DDM-paradigm*.

Recently a group of four algorithms, referred to as the *'DVS-algorithms'*, which fulfill the *DDM-paradigm*, was developed. To derive them a new discretization method, which uses a non-overlapping system of nodes (the *derived-nodes*), was introduced. This discretization procedure can be applied to any boundary-value problem, or system of such equations. In turn, the resulting system of discrete equations can be treated using any available DDM-algorithm. In particular, two of the four *DVS-algorithms* mentioned above were obtained by application of the well-known and very effective algorithms BDDC and FETI-DP; these will be referred to as the *DVS-BDDC* and *DVS-FETI-DP* algorithms. The other two, which will be referred to as the *DVS-PRIMAL* and *DVS-DUAL* algorithms, were obtained by application of two new algorithms that had not been previously reported in the literature. As said before, the four *DVS-algorithms* constitute a group of preconditioned and constrained algorithms that, for the first time, fulfill the *DDM-paradigm*.

In view of these facts our research group has carried out a project to explore the effect of discretizing a groundwater flow model applying DVS Methods. DVS formulations allow developing codes that meet the paradigm DDM, i.e. in which the solution of global problems is obtained only by resolution of local problems. The purpose of this work is to present the state of this project and the advances we had been obtained in this manner