The Problem of Programming High Performance Computers

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The many advances in parallel and distributed computing and related technologies have propelled high performance computing to its present state of scientific and commercial success. Yet, despite such success, programming high performance computers remains difficult, time consuming and error prone. Exacerbating the situation are the many existing legacy programs together with those written by programmers with widely varying backgrounds and experience. Understanding high performance computing programs helps to: identify program fragments that could be optimized; understand the overall algorithms or techniques used; and, enhance, maintain and integrate existing programs into new operational environments. A goal of this research is to propose developments aimed at improving the programming environment for high performance computing programs. Part I of this talk characterizes the essential nature of parallel programming as one of conceptual specification and conceptual understanding. Conceptual domains inherent in parallel programming models are explored by examples drawn from vector FORTRAN programming on the IBM VF180, Occam 2 programming on transputers and C/MPI programming on an Itanium 2 cluster. A visual/visualization approach to parallel programming is proposed. This approach has, initially, been developed into the Advanced Relation Model for Program Visualization (ARM 4 PV), and an extension to parallel programming is introduced in this talk: ARM 4 PPV. Visualizations of several programs, including a C/MPI program, complete this part of the talk. Part II of this talk has a focus on two important concepts, computation and communication. Our work in Optical Bus Parallel Computing Models is described in terms of the computation and communication aspects of the model.