THE DESIGN, IMPLEMENTATION AND EVALUATION OF JADE: A PORTABLE, IMPLICITLY PARALLEL PROGRAMMING LANGUAGE

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Over the last decade, research in parallel computer architecture has led to the development of many new parallel machines. These machines have the potential to dramatically increase the resources available for solving important computational problems. The widespread use of these machines, however, has been limited by the difficulty of developing useful parallel software. This thesis presents the design, implementation and evaluation of Jade, a new programming language for parallel computations that exploit task-level concurrency.

Jade is structured as a set of constructs that programmers use to specify how a program written in a standard sequential, imperative language accesses data. The implementation dynamically analyzes these specifications to automatically extract the concurrency and map the computation onto the parallel machine. The resulting parallel execution preserves the semantics of the original serial program.

We have implemented Jade on a wide variety of parallel computing platforms: shared-memory multiprocessors such as the Stanford DASH machine, homogeneous message-passing machines such as the Intel iPSC/860, and on heterogeneous networks of workstations. Jade programs port without modification between all of these platforms.

We evaluated the design and implementation of Jade by parallelizing several complete scientific and engineering applications in Jade and executing these applications on both shared-memory and message-passing computational platforms. Our evaluation focuses on two properties of Jade: how well it supports the process of developing parallel programs and how well the resulting programs perform. We found that Jade does not usually impose an

onerous programming burden - the vast majority of the changes required to parallelize the applications were confined to small, peripheral sections of the code and did not perturb the overall structure of the program. The coarse-grain applications perform very well, exhibiting almost linear speedup up to 32 processors on both computational platforms. Several of the finer-grain applications suffer from some Jade-specific performance problems, but some of these problems could be eliminated with a more advanced Jade implementation.

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