**Title and Subtitle**

Translation Tools for High Performance Computing

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**Abstract**

In this report we describe our efforts to design and construct tools for parallel software for highly parallel computers. Applications include gas dynamics and ocean circulation on computers such as the CM-5 and Cray T3D.

**Subject Terms**

compilers, massively parallel processors, software

**Distribution/Availability Statement**

Fully Available

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**Number of Pages**

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**Price Code**

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Overview
The goal of this research was three-fold: to refine a programming model that allowed serial codes to be translated to highly parallel form, to construct translators to perform this conversion, and to measure and understand the performance achieved when executing these codes on highly parallel machines. We succeeded in all three goals and applied our techniques to three different codes to validate our approach. In this report we summarize these results and describe the papers published, students graduated and research products produced.

Results and Transitions
In this research we validated the Fortran-P programming paradigm, applied it to three different computer codes (PPM, MICOM, and ARPS), and measured the performance achieved on massively parallel computers including the CM-5 and the Cray T3D. Good performance and high efficiency was achieved with these codes but we did learn that data parallel Fortran’s like HPF and CM-Fortran are harder to optimize than message-passing programs, though the former are perhaps easier for the programmer to use.

Though successful, economic and technical problems have made MPPs less viable today and we have improved the Fortran-P model (with further ONR support) so that it may be used to develop codes for clusters of multiprocessors machines often referred to as SMP clusters.

A variety of students have been supported under this grant: they are listed below. Aaron Sawdey has been the primary researcher on this project, and he is now supported on another ONR grant pursuing his Ph.D. and continuing his highly successful efforts from this grant. In addition, a total of 11 publications and 3 technical reports resulted from this work.

Products from this research include the following:

- **Parallel Ocean Model:** we parallelized the Miami ocean model and have made it available to other researchers on the WWW. Approximately 3-4 sites are using this code, including several in Europe.
- **Fortran-P translator:** we wrote a translator that converts Fortran-P codes to data parallel form and used it to convert the PPM gas dynamics code for execution on the CM-5 parallel computer. Though useful, this code is not robust enough for general release and interest in the CM-5 is declining with the demise of TMC.
- **Miami Ocean Model Calculations and Movies:** using our parallel ocean model we computed a high resolution North Atlantic simulation which achieved good fidelity
to observed Gulf Stream currents, something which had hitherto not been seen in ocean models. This increased resolution and speed afforded by the parallel model was thought to have provided this improved fidelity. We created several scientific animations from this calculation, some of which can be seen on the WWW at http://www-mount.ee.umn.edu/~dereklee/micom_movies/micom_movies.html.

Graduate Theses Supported (University of Minnesota)

Note: Some of the students received only partial support from this ONR grant while completing their graduate studies.

<table>
<thead>
<tr>
<th>Student's Name</th>
<th>Date</th>
<th>Degree</th>
<th>Thesis Title</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dr. Dahl is now in the Compilers Group at Silicon Graphics Inc., Mountain View, CA.</td>
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<tr>
<td>Peter Bergner</td>
<td>Dec. 1993</td>
<td>Masters</td>
<td>Minimizing Spill Code in Graph Coloring Register Allocators via Arc Spilling.</td>
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<tr>
<td>Olivier Meiraghe</td>
<td>April 1994</td>
<td>Masters</td>
<td>Software Testing for a FORTRAN Compiler</td>
</tr>
<tr>
<td>Derek Lee</td>
<td>Feb 1995</td>
<td>Masters</td>
<td>Scientific Animation</td>
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Software Developed

[1] Parallel Ocean Circulation Model: a parallel version of the Miami ocean model developed for the Cray T3D massively parallel processor and SGI Challenge multiprocessor now used at Caltech and the University of Miami. This parallel ocean model and related pre- and post-processing software is available on the Web at URL address: “http://www-mount.ee.umn.edu/~sawdey/micom.html”. As of July 1996 there have been 2800 accesses to this Web page.


[3] Fortran-P Translation Tool Kit: set of tools for developing all kinds of translation systems; used to date to construct the Fortran-P translator and other translation systems.

Papers Published

Journal Publications


Book Publications


Conference Publications
Research Products

Digital Movies: MPEG movies from the calculation described in journal reference [11] are available on the WWW at URL address: "http://www-mount.ee.umn.edu/~dereklee/micom_movies/micom_movies.html". These movies were recently referenced by Semtner in his article on computer simulations of ocean circulation which appeared in the September issue of Science. As of July 1996, there have been 2755 accesses to this Web page. Actual data from our runs is also available at the Web site.

Technical Reports

