Programming Tools on the T3E: ARSC Real Experiences and Benefits.

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Arctic Region Supercomputing Center

Mission

To support computational research in science and engineering – with emphasis on high latitudes and the Arctic

http://www.arsc.edu/

Research at the University of Alaska Fairbanks

"The Arctic University of the United States"

Institute of Marine Science

Institute of Arctic Biology

Geophysical Institute

◆ **Arctic and subarctic focus**

◆ **Cooperate with Canada, Russia, circumpolar nations**

◆ **$68 million annual research budget**

◆ **Sponsors include: NSF, NASA, NOAA, DOD, USDA, DOE, DOI, industry foundations, state/local government**

Center for Global Change & Arctic System Research

Cooperative Institute for Arctic Research

IARC

International Arctic Research Center

Institute of Northern Engineering

School of Agriculture & Land Resources Management

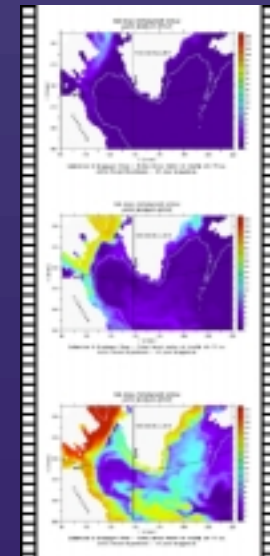**ARCTIC REGION SUPERCOMPUTING CENTER**

From Numbers to Images

Compute ➡ **Store** ⬌ **Visualize**
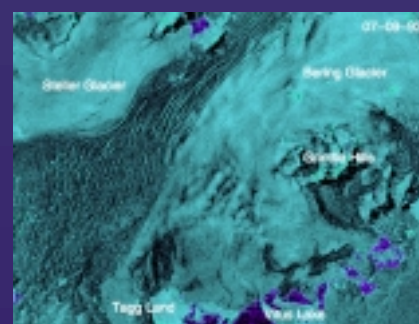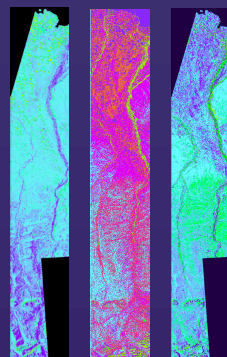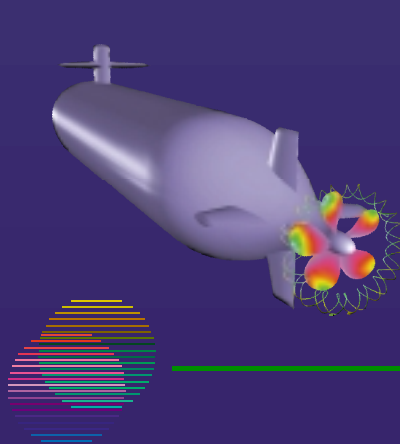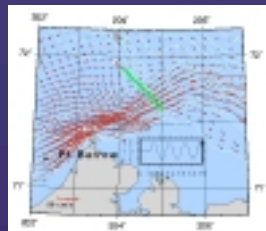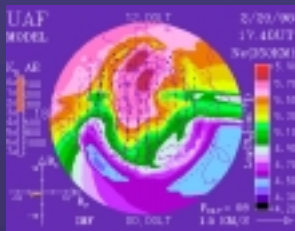
User Satisfaction

- **Keeping different types of users happy**
  - ❖ **Small and new users**
  - ❖ **Large users**
  - ❖ **Challenge users**
- **Working individually with users**

  - ❖ **Code and system optimization for better utilization of systems**
  - ❖ **More flexible use of processors**
  - ❖ **Optimal use of storage**
  - ❖ **Better scripts and data management**

Tools.

- ◆ **Debugging, performance monitors.**
    - ❖ Totalview, write.
    - ❖ Apprentice, PAT, VAMPIR (both MPI and shmem), write.
    - ❖ Develop user skills and encourage application.
- ◆ **Languages and libraries.**
    - ❖ HPF, pghpf for a few suitable projects and rapid development work.
   - ❖ Coarray and future trends.

Use of Tools

- ◆ **Ocean acoustics model modified so that the control processor reads next data slice while other processors compute particle paths**

- ◆ **Several codes modified to run on a range of processors in order to "fit" into system**

- ◆ **Input/output modified for maneuvering submarine challenge data analysis code to better use ARSC system**

VAMPIR tool example.
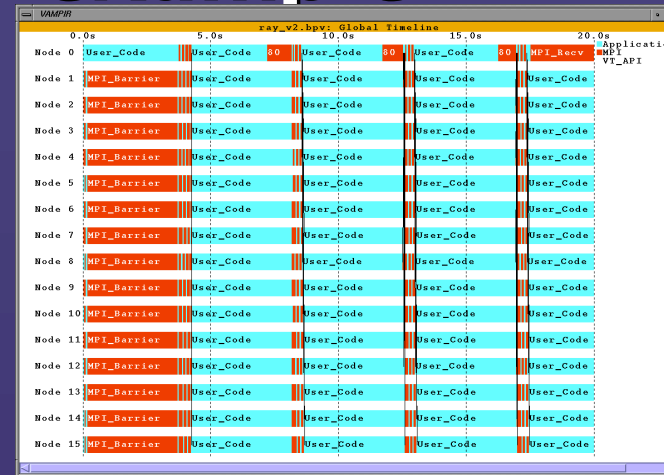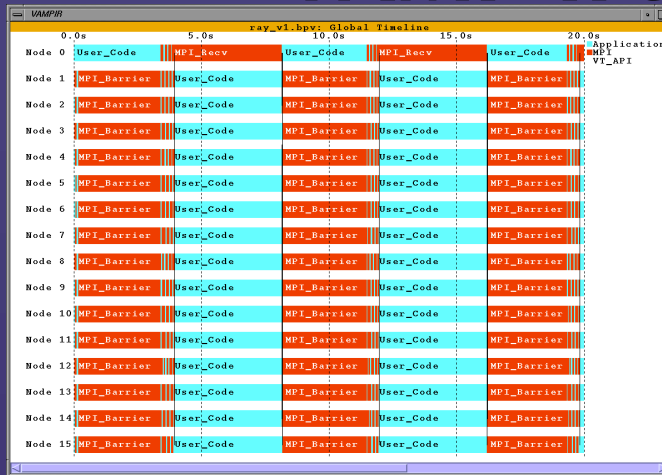
- ◆ **VAMPIR allows users to inspect message passing.**

  - ❖ **Considerable detail and information available.**

  - ❖ **Easy to identify areas for improvement in algorithm. Great help when fine tuning across different architectures/problem sizes etc.**

  - ❖ **Also VERY useful for training and explaining how code works.**

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What is needed to encourage use.

- **Good system configuration.**

  - ❖ **Friendly queue structure and explain why it is so.**

  - ❖ **Big fast filesystems.**

    - ✦ **Both for data storage and checkpointing.**

  - ❖ **Safe jobs from users.**

    - ✦ **And good habits while jobs are running.**

- **Encouragement.**

Individual Support

- **ARSC makes an effort to interact directly with all users**

- **Individual support for users focuses on three areas**

    - ❖ **Tool utilization to inspect and improve code performance**

    - ❖ **Suitable configuration and use of scheduling systems**

    - ❖ **File system configuration and good data management practices to make optimal use of available resources**

- **Proactive inquiry of rogue code behavior noticed by staff**

Job Scheduling

- **Well-publicized and enforced queue policy**
- **Special queue designed for Challenge Projects**
  - ❖ **Next available execution slot**
- **Modify queue structure to fit user needs**
- **Assist users in chaining jobs rather than submitting multiple jobs**
  - ❖ **More equitable sharing of resources among users**
- **Dedicated sessions arranged as required**
  - ❖ **Application of tools**
  - ❖ **Demonstrations**

Encouragement.

◆ **Centre users.**

❖ **Peer pressure is much better than expert advice.**

❖ **ARSC T3E newsletter.**

◆ **Vendors of hardware and software.**

❖ **Need convincing to support tools.**

❖ **HPCrequirements task force.**

◆ **'Regularity and Good Habits.**

ARSC T3E Newsletter.

- **Regular email distribution of T3E and parallel information and tricks of the trade to both users and other interested parties.**

  - Over 300 subscribers. WWW reference point.

  - Passed round within many organisations, including SGI/Cray and other supercomputer centres.

  - Aims at applying peer pressure. Users are more likely to follow the example of fellow researchers that expert advice.

Task Force on Requirements for HPC Software and Tools.

- **Many wise and experienced people carefully selected from HPC sites, vendors, users, government etc.**

- **Considered what was productive, what would be productive.**

- **Generated a list of required software for both users and systems.**

- **Find all the details at:**

  - ❖ **http://www.nacse/org/projects/HPCreqts/**

Regularity and Good Habits.

◆ **Ever noticed some of the best codes are those that have moved around more.**

◆ **Testing software, computationally and, in some cases, scientifically.**

◆ **Basic checks and balances, in scripts in particular.**

◆ **Users ask "what can they do at home"?**

    ❖ **It is hard to do testing and development work at a fine scale on a production supercomputer.**

Role of PC Clusters.

- ◆ **PC Clusters are not the enemy,**
  - ❖ **if you make them your friend!**
- ◆ **Provide valuable resources.**
  - ❖ **Good training and development environment if well configured and supported.**
  - ❖ **Don Morton, University of Montana, Dept. Comp. Sci.**
    - ✦ **Paper at the Spring 1999 CUG in Minneapolis.**
    - ✦ **Training course, similar tools, experiences in crossing from cluster to a supercomputer environment.**

Benefits?

- **Tools help users generate correct and faster code!**
    - ❖ **Tools make it easier/possible for users to generate correct and faster code.**
- **Good tools encourage users to modify/improve code.**
    - ❖ **Safely, with confidence.**
- **Robustness of code leads to the ability to take advantage of new systems or expansions.**
- **Centre gets an active community and more results.**

System Progression

Upgrades in power, speed, memory, and storage over the years

272 CPU–T3E 90
(230.4 GFLOPS)
450 MHz

68 GB RAM

12 CPU–J90
8 GB RAM

11.5+ TB Silo

104 CPU–T3E 900
(84.6 GFLOPS)
450 MHz
26 GB RAM

12 CPU–J90
(24 GFLOPS)
8 GB RAM

11.5+ TB Silo

88 CPU–T3E
(48 GFLOPS)
300 MHz

13 GB RAM

128 CPU–T3D
8 GB RAM

8 CPU–YMP
(2.6 GFLOPS)

128 CPU–T3D
(19.2 GFLOPS)
2 GB RAM

4 CPU–YMP
(1.3 GFLOPS)
1.1 TB Silo

1993   1994   1995   1997   1998   1999

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What Next?

- ◆ **Does hardware matter?**

  - ❖ **Most users have an MPI code so any MPP will do?**

- ◆ **Tools make a difference?**

  - ❖ **Finding bad spots in a code and look to improve these.**

  - ❖ **How to support mixed mode programming.**

    - ✦ **MPI v shmem v openMP v co-Array v HPF v ??**

  - ❖ **Looking at better algorithms.**

    - ✦ **Rapid growth away from authors original problem size.**

Conclusion.

- ◆ **Centres/Vendors must provide support for good tools, both for programming and system activity.**

  - ❖ **Items can come from ISV/Opensource.**

- ◆ **Centre and users must work together to arrive at suitable configurations.**

  - ❖ **Essential for a diverse userbase such as that at ARSC.**

- ◆ **Future looks challenging from any direction.**

  - ❖ **But, in such an environment the best things happen.**