

**Evaluation
of the
HPC Program at
University of Tromsø**

June 2000

Executive summary

The task given to the evaluation committee was to provide the steering committee for the High Performance Computing (HPC) program at the University of Tromsø (UIT) with comments and recommendations for the coming three years of activities in the program.

The committee is pleased to be able to report that the HPC program is providing an indispensable service to the university. The existence of the program has enabled research in areas where access to HPC is of vital importance and provided the university with valuable external contacts. The existence of the program has also constituted a basis for UIT's participation in the national HPC program.

Judging from the interviews with users and the outcome of a user survey which was performed during the spring of 2000, the users are indeed satisfied with the services provided and regard the program as a very valuable resource.

The impression is thus that of a well functioning university program for HPC. In view of the coming participation in the national HPC program the Tromsø program is facing an expansive period with hardware upgrades, recruitment of new staff, initiation of education out-reach and training efforts, etc. The comments included in the report should be viewed in the perspective of these planned changes and be seen as recommendations and suggestions for the transition and a chance to further improve the high level of services provided.

During the evaluation the committee has identified 4 categories which should be given attention in the planning and development of the program.

1. The contacts with researchers in established HPC related areas must be further developed
2. Out-reach programs to identify new users must be given highest priority
3. Resource allocation procedures must be improved and enforced
4. Operational routines for monitoring turn around times and for the production of other usage statistics must be established

The majority of the recommendations given in the report can be regarded as a consequence of the items above.

1 Objective and Background

The overall objective of the evaluation is to provide the steering committee for the HPC program at the University of Tromsø (UIT) with comments and recommendations for the second half of the execution of the HPC program.

The evaluation was performed by a committee consisting of:

- Professor Anders Ynnerman, Nationellt Superdatorcentrum, University of Linköping (Chairman)
- Professor Fred Godtliebsen, Department of Mathematics and Statistics, University of Tromsø
- Doctor Reinert Korsnes, Norwegian Polar Institute

The evaluation is based on:

1. Background documentation provided by the program "En kort Oversikt over Tungregneprogramt ved Universitetet i Tromsø"
2. Other documentation and information available at the web site for the program
3. A user survey conducted by the program during the spring of 2000
4. Presentations and interviews with users during a site visit on 20-21 June 2000

The site visit was conducted according to an outlined schedule but in a flexible spirit to enable adjustments and extraction of the required information for the production of this report. It is somewhat unfortunate that, due to circumstances beyond the control of the committee or the program management, there was a low attendance of staff and some cancelled user interviews.

The views of the evaluation committee on each of the evaluation criteria, as specified prior to the evaluation by the chairman, are given in the following sections.

2. Vision and Scope

The vision as presented in the available documentation and during the site visit, is very ambitious. The aim to "Make scientists at the University of Tromsø the most efficient users of high performance computing(HPC) in Norway..." is admirable and well defined in the

spirit of healthy national competition between universities. A vision of this kind does, however, lead to goals, which require significant and continuous input in terms of funding for hardware, staff and competence dissemination in general.

The second part of the vision "Create the best support environment for any HPC user in Norway, and present them to the most efficient solutions to support their highest demands in HPC", emphasizes UIT's ambition in the context of a national HPC program. This part is interpreted as a long-term desire and obviously a vision which is appropriate for a lead site in a national HPC program. The demands on the organisation and available resources is further increased by this part of the vision.

The vision breathes foresight and enthusiasm and is clear and well defined. It could, however, be argued that given the level of funding (past and future) as presented during the evaluation, it will be hard to closely connect the goals for the future work in the program to the vision, which indeed infers a very wide scope of the program and sets a very high level of ambition.

Definitions of goals from vision

The goal of the program was presented as:

"The HPC program at the University of Tromsø is focused on understanding the principles of HPC and develop effective usage of HPC resources, both locally and nationally. This will be done by building a powerful parallel programming support system and give the users access to highly available, easy accessible, state of the art equipment in a powerful programming and processing environment"

The goal follows naturally from the vision statement. It does, however strike the evaluation committee as somewhat odd that there is such a strong focus on the parallel computing aspect of HPC given that a large fraction of the actual usage of the resources provided is non parallel.

In the same manner as the vision requires significant input the goals are also very demanding and should be broken down into key milestones for the program to enable a closer connection between, vision, goals and actions

In view of the stated goals a larger fraction of the available resources should be reserved for parallel applications.

Definitions of actions from goals

The actions as presented in the budget overview are:

- Hardware procurements
- Plant and operations
- Application support
- Education, Outreach and Training
- Software licences
- Project management

The actions as defined are well suited for the program. Each action should, however, be accompanied by key milestones, which are put in the context of the available funding for the program.

Balance between actions

In many HPC programs worldwide there has been a very strong emphasis on hardware at the cost of insufficient operations, user support and outreach activities. The committee is pleased to see that the program at UIT has not fallen into this trap. The overall balance of the total expenditure, as calculated between 1997-2003, seems to be close to 50% hardware and 50% other activities. It should, however, be noted that most of the outreach activities will start during 2000 and for the forthcoming years will depend upon the funding that is expected from the national program. It is also noted that the number of staff has increased over the past 6 months which explains why some of the activities are at a development stage.

It is recommended that the program make a continuous effort to maintain the balance between actions as presented in the budget outline. One immediate action, which should be given high priority is the creation of a forum for HPC users at UIT. The scientific advisory board should be used as the point of contact for this forum, which should host seminars, conferences, workshops and possibly guest researchers in HPC related areas.

3. Organisation and administration

The choice of placement of HPC programs within a university is an important factor which affects the profile of the program at large and the daily work within the program. There are, in principle, three different choices for a university hosted program:

1. An independent center placed directly under the governing body of the university
2. A center linked to a department, often with close connections to a research group(s) in an HPC related area
3. A center placed under a central IT-organisation with, general responsibility for IT infrastructure at the university level.

The HPC program at UIT falls into the third category. This choice is appropriate considering the size of the program, which is benefitting from significant leverage from the support organisation at the "IT-avdelningen". Furthermore as was discussed during the evaluation there is currently no research group in scientific computing at UIT, which makes the choice of placement even more appropriate. However, if research in scientific computing were to be initiated, the HPC program could benefit from a close collaboration with such a research group and in an ideal scenario the advantages of both placement 2 and 3 above could be achieved.

Steering committees and leadership

The organisational structure for HPC within UIT is well defined. A steering committee is appointed by the IT council at the university level. The steering committee in turn delegates operational responsibility to the "IT-avdelningen".

The challenge in this setup is the interface between the domain governed by the IT council and the domain governed by the "IT-avdelning". Unless this interface is clearly defined areas of responsibility in terms of budgets, policy, decision making and chain of command may become blurred. At UIT this potential pitfall is overcome by having well defined procedures and an overlap between individuals operating in both domains.

Operations

As pointed out above placement of operations under the IT-infrastructure is somewhat uncommon. The evaluators were impressed with the ease at which the operations seemed to be running. Many of the problematic operational issues encountered by other major HPC installations seem to be overcome through the sharing of personnel between the subprograms in the "IT-avdelning". The active involvement in the operations by the management of the "IT-avdelning" is commendable.

Application support

The application support consists of help desk activities, limited in-depth user support, and organisation of conferences. The main

information channel for the project is the website, which contains comprehensive material. Even though each of these aspects of the application support seems to be functioning well, there is room for improvement. The profile of the staff, see below, limits the scope for application support. One of the main motivations for running a local HPC center at a university is the contact network with local researchers that can be established. Such a network enhances the centers potential to perform competence dissemination and spread the use of HPC to new research areas. The current contacts with research groups that the HPC program at UIT maintain seem to be long term well established contacts and in many cases based on previous personal contacts between staff and researchers. Plans for an expanded out-reach program were presented and scheduled to start during 2000.

It is recommended that the program makes a strong effort to immediately initiate the out-reach efforts outlined in the future plans.

Scientific advisory board

There is a scientific advisory board "Kompetensenettverket" connected to the program. The function of the board was not made totally clear to the committee. The advisory board seems to have a function in terms of general HPC information and serves as reference panel for third party software. The board meets once a year.

Considering the visions, goals and motivations for a university HPC center it is clear that the interface to local researchers is one of the most important aspects of the program. An advisory board should therefore actively be used as a vehicle for scientific contacts. Furthermore the ability to engage researchers in the activities at a center often depends on the proximity to researchers in areas close to scientific computing. Such a research group does not currently exist at UIT.

To reach the specified goals regarding the relevance for local researchers and further promote the use of HPC at UIT the scientific advisory board should be actively involved in the planned out-reach efforts and serve as an extension of the program to relevant research areas. This entails hosting conferences, guest researchers, seminar series, etc.

It is also recommended that UIT initiates the build-up of research in scientific computing to improve the HPC program and complement the education, training and out-reach initiative taken by the program. Such a research group would also serve as a recruitment ground for the program.

Size and competence profile of staff

In the program there are currently 3.25 full time equivalents working. As mentioned earlier the number of staff seems appropriate and in balance with the hardware investments. It was, however, noted that there has been a recent expansion in the number of staff and it is judged that the staff in previous years has been undercritical. The sharing of responsibilities with the "IT-avdelningen" provides the critical mass of personnel required to maintain high quality operations.

During the evaluation only one member of staff was present. The impression was, however, that all of the staff maintain a very high competence level regarding operational aspects. The in-depth expertise on the existing hardware was acknowledged even by the representative for the hardware vendor (Hewlett Packard(HP)). The collaboration in terms of 50% funding for one support person has from a competence profile point of view been of obvious benefit to both the HPC project and HP.

Even though the staff exhibits a deep understanding of research issues and has good contacts with the users no Ph.Ds are employed by the program. It is also noted that all staff members have either a physics or mathematics background.

It is recommended that the staff members are given the opportunity to actively be engaged in research efforts through in-depth support to strategic research groups. A possible scenario would be shared funding of staff between the program and research groups.

It is also recommended that the project makes an effort to widen the competence profile of the staff to areas where there are large user groups or towards new areas in which the use of HPC has high potential benefits. An obvious area of immediate focus would be chemistry.

4. Technical aspects

Technology choices

The HPC project at UIT is very focused on the HP architecture and has, as discussed under Point 9 below, entered into a partnership with HP. The focus on mid-range SMP machines is appropriate considering the mix of users who are mostly using codes not suitable for large scale parallel distributed memory processing. One could argue that users would be encouraged to make parallelisation efforts if large scale parallel architectures were available. However, these users can expect to be offered access to systems of this kind through the national initiative NOTUR.

Computing capacity

The main system exhibits a capacity of 28.16 Gflop/s and has 6Gb of memory. Both the capacity and total memory is at the low end of what is needed for a university level system at this time. The planned upgrade and merging of existing systems will make the system more attractive and provide a significant increase in total capacity.

Data storage hierarchies

The secondary storage consists of approximately 150 GB of hard disk. Tape storage for backups is provided by the IT-services at UIT.

The disk storage is at the very low end of what should be provided.

It is recommended that data storage hierarchies are given higher priority in the future. To be able to provide a competitive environment at least 1 Tb of disk storage and tape storage up to 10 Tb must be provided in a hierarchical seamless environment.

Visualisation equipment

The HPC program at UIT does not provide any visualisation services. The close connection between HPC resources and visualisation is an area in rapid development. Most centers for HPC are providing visualisation services, often in connection with local research groups in the field.

UIT should consider the development of visualisation services and research in connection with the HPC program

Networks (internal and external)

All the systems provided by the program are connected on a 100 Mb/s fast ethernet. The university backbone is connected to the 155 Mb/s national network. The network situation is similar to most other universities and HPC programs and requires no immediate changes. It was, however, pointed out that the band width to the non-academic partners was not sufficient.

The network connection to Norsk Polarinstitut must be upgraded to enable the external users to truly benefit from the partnership.

Distributed filesystems

The HPC program does not support any distributed file systems. Given the fact that there are several different resources available this fact is somewhat surprising, but can easily be rectified. A distributed file system would facilitate a migration between various resources, present and future, to the benefit of the users and systems administrators.

In connection with the expansion of the storage hierarchy as proposed above, the program should consider the implementation of distributed file systems.

Security solutions

Standard unix security level is provided. Considering that the operations are taking place in an open academic environment this is sufficient and imposes minimal constraints on the users. The plans to introduce secure shell is a natural step considering the increasing number of reported break ins. The plans are supported by the committee provided that the users are given the necessary support to ensure minimal changes in routines.

5. Allocation policy

Application procedure

One of the most important aspects of a university level system is that it provides easily accessible HPC resources. It could then be argued that every single researcher at the university should be allocated resources on the system. It is, indeed, the opinion of the committee that no evaluation should be required to gain access to the system and to receive a small amount of resources.

At UIT users can apply for resources from the HPC program twice a year. A simple application form is provided and a maximum time of 2000 CPU hours can be granted for the period. If a user runs out of resources extensions can be granted upon request. The resources are granted without any scientific or technological evaluation. This constitutes a potential problem in terms of over allocations and consequently the turn around time on the system. If the batch queues on a system are allowed to become too long the system will no longer provide a valuable resource and researchers are better off using personal dedicated and more cost effective platforms. The only way in which it can be ensured that the expensive HPC resources remain valuable tools is to limit the allocations and make priorities based on scientific and technological considerations when allocating the resources.

The program should make use of the scientific advisory board to establish routines for evaluation of larger proposals and make priorities. The evaluation routines should be harmonized with the national HPC program.

Documentation of projects and results

The ultimate measure of the success of an HPC program is the scientific output that stems from the use of the resources, through collaborations with the program, etc.

The UIT program has indeed provided the committee with a thorough account of the scientific output through documentation and the user presentations during the evaluation. There is a list of publications on the program's web site and the compiled report that was made available prior to the evaluation contained statistics on the number of publications sorted by discipline. As expected from the usage statistics most publications were found in the area of chemistry. The comments made in connection with the staff profile above obviously has bearing on the user profile and scientific output and should be considered also in this context.

An integral part of the above recommended out-reach program is a dedication to widen the user profile.

Users should be required to include a standard wording in the acknowledgement of publications that stem from the use of HPC resources provided by the program

Enforcement of allocations

Currently allocations of resources are not enforced.

At the same time as evaluation routines are established an enforcement mechanism should be implemented. Ideally the mechanism would allow users who have run out of resources to execute jobs in low priority queues to avoid idle time on the machines.

6. Level of service provided

The following are some of the evaluation committee's views on the level of service provided. The task of evaluating this aspect of the program was made somewhat difficult by the lack of statistics on some key items. The comments are therefore in these cases based on the interviews with the selected users and the discussions with the staff at the center. The overall impression is that of a very well functioning center providing a high level of service to its users.

It is strongly recommended that the program considers each of the headlines below and makes sure that statistics are made available in the form of quarterly reports both for internal and external use.

Availability of systems

The resources provided by the program are available 24 hours a day 7 days a week. The availability does not seem to be affected by the limited on-call services. The stability of the hardware, see below, is of course contributing to the high level availability.

Down time statistics

The systems exhibit an impressive up-time of 99.5%, which indicates the stability of the platform as well as the unusually high competence of the operational staff.

Response times

The users of the system were pleased with response times of the system apart from the users at the Polarinstitute who were concerned with the slow network connection to their site.

Queue times (interactive and batch)

No proper account of the queue times was given during the evaluation. This problem was discussed during the evaluation meeting and the staff immediately took the appropriate actions. Careful investigation of the queue statistics will most certainly provide useful information for future scheduling policies.

System load and distribution

The committee feels unable to provide any comments on the system utilization which was stated to be close to 100%. In other installations known to the committee the ambition is to maintain 80% utilization to avoid excessively long wait times in the batch system. This is of particular importance for jobs requiring more than 1 CPU.

It is clear from the user survey that the facility is used both for sequential and parallel applications. It would, however, be of interest to produce statistics on the mix of and type of jobs to evaluate the need for parallelism in the program. A larger fraction of parallel jobs would most certainly affect the load on the system and the queue situation. An indication of the job mix is found in the responses to the user survey.

Backup procedures

The available systems are connected to the backup facilities as provided by the "IT-avdelningen". This seems to be a very good arrangement and no problems were reported by the users. When the disk storage area is expanded according to the outlined plans, backup procedures may need to be modified to selectively backup a limited number of file systems.

File migrations

The program does not provide any file migration.

Provided software

A large fraction of the users develop their own software. The software provided is listed on the web site. The set of software is driven by user requirements and contains the most commonly used third party packages as well as compilers, appropriate tools for parallel computing and numerical libraries.

It is recommended that the program encourages users to suggest software purchases in future user surveys

Help desk activity

Users are very pleased with the help desk support given by the program. Typically 5 questions are received per week and are mostly connected to the hands-on use of the system. The policy of the program is to respond to each question within 24 hours. In practise answers are provided much faster. As new users from areas with less experience are recruited as a part of the out-reach program, the number of questions will most certainly increase dramatically.

Documentation of hard and software

All the documentation produced by the program is available on the web site, see below. This is appropriate and there is no need for any further documentation at this point.

Quality and use of user support

There is no doubt that the provided user support has been extremely valuable and has been an enabling factor in several research projects. In the past years a number of in-depth projects have been performed during which approximately 10 user codes have been ported to the HP architecture. In 50% of the cases the support involved parallelisation efforts. These efforts were based on use of parallelizing tools.

Courses and seminars

An introductory workshop day was organized in 1998 and addressed optimization and parallelisation on the HP architecture. In 1999 UIT hosted the annual HiPer conference, which was deemed very successful and boosted the interest for HPC at UIT.

Courses on the use of the available HPC resources should be developed and held regularly as a part of the new education and out-reach program

News bulletins

The program issues news bulletins on the web site and uses modt messages to communicate with the users. The current number of news items on the web-site are relatively few and with long intervals in between.

In order to make the web site a primary source of information for users an effort should be made to issue news bulletins at regular intervals

WWW pages

The web site for the program is well designed and easy to navigate. The hardware specifications are useful. A user guide for the "Victorio" system was available but there seems to be no link to the current location of the guide.

An online project catalogue is currently under construction.

The web site is also used to publish internal documentation for the administration of the program and the benefit of the evaluation committee.

7. User satisfaction

The comments made in this section are based on the results of the user survey and to some extent on the interviews with selected users conducted during the evaluation meeting. Even though the user survey gives the picture of a very satisfied user community, some of the most useful information for the program management as it strives for continuous improvement is most likely to be found in the answers from users who express a dissatisfaction with certain aspects of the program.

The program should follow up the user survey with individual contacts in cases when users express discontent with certain aspects of the program

Allocation procedures and granted time

There seemed to be no comments regarding the allocation procedures. In view of the ease with which accounts are provided and the allocation procedures, as discussed above, this is expected.

Allocation management procedures

The informal way in which allocations are managed is appealing to the users and relies upon the well functioning dialog between the staff and the users who expressed very positive opinions during the

interviews. Allocations were, however, not covered by the user survey.

Available hardware resources

The users are in general very content with the processing speed of the available resources. Even though users are in general also pleased with the disk capacity and available memory there is a slight indication that storage has been under emphasized in comparison with processing speed.

Available software resources

The users indicate that the program provides a good selection of software and that the user environment is good. There are, however, a few users who are evident and report discontent. As pointed out above the program should initiate a contact with these users to eliminate the cause of these responses.

In future surveys users should be given opportunity to include comments in connection with each question

Help desk

With the exception of a few users who have experienced problems with the help desk the overall impression is very positive. The answers regarding response times should be viewed in the light of the policy that questions should be answered within 24 hours.

The program could consider an increase of the ambition in terms of response times for the help desk.

In-depth user support and courses

A majority of the users feel that the support has been of importance in porting their applications. A large number also feel that the user support has enabled them to optimize their codes. This response harmonizes with the information on in-depth support as provided by the staff at the center during the evaluation.

Only 4 users covered by the survey have attended any courses or training seminars arranged by the program. Still a majority of the users feel that the number of courses is adequate. This fact indicates that the user community consists of experienced users. It was clear from the evaluation meeting that this is indeed the case for many users in chemistry and physics. It also underlines the previous recommendations for the program to seek a wider user base and initiate competence dissemination to attract less experienced user groups.

Information flow from the program

Most users regard the information on the web site as very good or good. It is noted by the committee that the web site is brief and clear and contains relevant information. As the program expands the web site will most likely expand to include more information on training and user support in a wider perspective. In particular the local user guide to Victorio available for down loading should be widely distributed.

Turn-around times for batch queues

From the users point of view the queue time is one the most important aspects of an HPC center. As for any shared resource wait time is a potential cause of frustration and discontent. It is therefore of highest importance that a well defined queue policy is available and that the wait times are closely monitored.

The interviewed users were generally content with the turn around times on the system even though at times the wait time in the "gigant" queue can be up to 5 days. In the user survey there is a slight indication of discontent with the turn around times. The program does not regularly produce any statistics on turn around times for the different queues and it is therefore hard to tell if there is any cause for concern in view of the user survey.

It is strongly recommended that the program establishes routines which closely monitor the turn around time for the different batch queues

8. Scientific output

Scientific output from projects

A list of publications stemming from projects which have made use of the HPC resources was made available to the committee. The list shows that from 1997-1999 105 publications were produced. The majority of these originated from the chemistry department.

The importance of the documentation of publications building on the use of the provided resources cannot be emphasized enough. The HPC program at UIT has in a most commendable manner taken this point very seriously and the comprehensive list of publications clearly shows the necessity of the project to the well being of several research groups at UIT.

Competence dissemination

It is the opinion of the committee that the planned out-reach program constitutes a natural next step for the program in reaching its

ambitious goal to "Make scientist at the University of Tromsø the most efficient users of high performance computing in Norway". A successful competence dissemination program will constitute an essential step towards reaching this goal and the plans as presented during the evaluation are strongly supported by the committee.

Documentation of projects

An on-line catalogue of the projects is currently being implemented. Catalogues of this nature have shown to be extremely valuable and should contain information on allocated and used CPU time per project as well as lists of publications.

The program is encouraged to proceed with the implementation of the on-line project catalogue.

9. Partnerships and collaborations

Extent of partnerships and leverage of academic use

The program has a close collaboration with Hewlett Packard and in fact one support person is partly funded by HP. As discussed above this set up has been essential for the program in providing the high level of technical support and maintenance.

The program also has a partnership with the Norwegian Polar Institute. It is generally hard to find partners for HPC programs and the committee is very pleased to see an example of a well-functioning collaboration of this kind. The leverage provided by the funding from NP to the program is significant.

The documentation provided lists a number of potential new partners. The program is encouraged to continue its efforts to find external partners.

Involvement of research partners in partnerships

The benefit for the program from partnerships of this kind lies partly in the leverage obtained for hardware resources and funding for operational costs, but also in the potential scientific collaborations with researchers at UIT which may grow from the partnerships. Possible ways of stimulating these kinds of collaborations are to allocate in-depth support staff to external partners on a part-time basis or engage local researchers in HPC related areas in projects with potential partners for the program.

It is recommended that the program actively encourages the collaborations in the HPC area between research groups at UIT and external partners

10. The role of UIT

An HPC program at a university plays an important role for the well being of research and education in many different ways. The impact on students and researchers must not be underestimated. An HPC center has a research enabling role as well as a mission to perform knowledge dissemination. The outcome of both these aspects of the HPC program are, however, sometimes hard to measure and strategic insight into the importance of the program is required at the highest university level.

The committee is very pleased to see that UIT has over the past three years supported the HPC program in a most commendable way. Funding was made available for the start up of the program in 1997 and funding to match the expected income from the NOTUR project will be made available.

It is the opinion of the committee that the current state of affairs at UIT bodes well for the future of the program and its part in the national HPC program. It is, however, noted that there are no research activities at UIT in the area of scientific computing. A research group in this area could provide a key element for the program in its out-reach programs and enable further collaborations with external partners.

It is recommended that UIT considers the development of research in scientific computing to strengthen the HPC program and complement the education, training and out-reach initiative taken by the program

11. Future development

The program is about to enter into the national HPC program and contracts specifying the UIT participation in the program are currently being negotiated.

Planned changes to organisation

In view of the role in the national HPC program a further increase in the number of staff is planned. The committee regards this as a natural step towards the specified goals and sees no need for any structural changes to the organisation, which is indeed that of a well functioning HPC center.

Planned upgrades

During the autumn of 2000 the current hardware will be upgraded to a system with 48-64 processors, 24-32 Gb of memory and 1-2 Tb of disk space. This upgrade is in line with the opinion of the committee.

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The upgraded system will constitute a state of the art university system. It is, however, possible, depending on user demand, that the system should be equipped with 1Gb of memory per processor.

Participation in the national HPC program

The committee feels that the participation in the national HPC program is an essential element in the continued development of the program and the key to the fulfilment of many of the recommendations put forward in this report.

Future profiling of program

The program has chosen to provide computational resources to users with codes that exhibit moderate scalability, i.e < 16 processors. This ambition is appropriate considering the current usage profile and is reflected in the choice of hardware.

It is the opinion of the committee that the future profile of the center as presented will ensure that the program remains a valuable resource for users at UIT and existing partners. In addition the program will also provide national users with access to state of the art SMP processors.

The education training and out-reach program will most likely be of increasing importance and focus as the program progresses towards its goals locally and nationally.