



A Discussion Paper on Academic Computing Services

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**Prepared for public discussion by the SFU
Community**

The Objective of the Review

We in Academic Computing Services, like many other units, have been charged with completing an open, transparent, consultative review of our services and our role within the university.

Our mission is to produce a 3-5 year strategic plan for Academic Computing Services with the intention of meeting the ongoing and emerging information technology needs of the SFU research and instructional communities in as cost effective manner as possible.

Appendix 1 lists the services and facilities currently supported by Academic Computing Services and Operations & Technical Support. This review will in essence determine the answers to the following questions for Academic Computing Services related activities:

1. What should we quit doing?
2. What should we start doing?
3. What should we do differently?

Purpose of This Report

The purpose of this report is to take the next step in the consultative process and ask the question: *What can we do to make you successful?*

I have prepared this report in order to provide some background for widespread discussion of this question. As background to preparing this report I have had discussions with all of the Deans and have consumed significant quantities of coffee with individual members of our community in more informal discussions. We in Academic Computing Services and Operations & Technical Support have spent a great deal of time discussing the issues that have emerged from the community as well as those that we see coming over the horizon.

At this stage of the exercise our primary focus is to make you, the members of the University Community, successful in your information technology related endeavors. This report discusses issues and proposals at a relatively high level along the lines of an Executive Summary. It does not delve deeply into details, nor does it deal with the budgetary implications of these discussion items. However, there are sections that will discuss the relative costs of things, but this is for comparative purposes not budgetary ones.

Later stages in this review process will address the budgetary impact of the results of these discussions to ensure that expenditures fit within the appropriate budgetary envelope.

Overview of the University's Computing Environment

This section refers only to the research and instructional activities supported by Academic Computing Services and Operations & Technical Support. There are also significant resources within and services provided by the Office of the Vice-president of Finance & Administration, the Registrar's Office, the Library, the Faculty of Applied Sciences, and the Faculty of Arts, all of which I have not commented upon.

SFU overall has a well integrated and well balanced set of services which supports a large and active community of users.

- There are 21,000 users of our services.
- Almost 85% of our undergraduates are using our services.
- There are approximately 7,000 computers on the network.
- E-mail has become of vital importance throughout the university.
- Demand for access to the network and access to services is continuing to grow.

In spite of these indications of success there are several significant issues which have emerged from discussions:

- There is a serious shortage of skilled computer support staff in the faculties and departments.
- Although personal computers are becoming less expensive, the expense of meeting increased demand for more computers as well as renewing obsolete computers has become prohibitive.
- Off campus access to the network is slow, and either congested or costly.

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- In spite of the ever lower cost of software packages, the overall cost of software acquisition and support is becoming a concern. This is a result of both the broad range of software required and the upgrade treadmill.
 - There are not enough computers available for students in the public labs.

Overview of the ‘World of Technology’

The two most obvious and significant developments in the ‘World of Technology’ are:

- The emergence of the World Wide Web as both a convenient and rich source of information.
- The personal computer becoming a commodity product resulting in phenomenal increases in computer power and storage capacity in consumer products.

Slightly less obvious but soon to be of significant importance is that the cost of communications is dropping even faster than the cost of computing. Although on campus we are enjoying the benefits of higher speed networks, as consumers at home, we haven’t yet experienced a significant improvement in off campus networking. These changes are pervasive however, and will result in faster, cheaper communications services.

In spite of the benefits and promises of technology, it also brings its share of troubles such as:

- The phenomenal level of hype purveyed by the vendor of technology products has raised expectations to unprecedented highs.
- Bothersome junk e-mail.
- Personal attacks via pornographic or threatening material from anonymous senders.
- Institutional ‘Denial of Service’ attacks via mail bombs and chain mail.
- Privacy and security breaches via known holes in operating systems, password cracking, network sniffers, and insecure or unethical Internet Service Providers.

Topics for Discussion

The remainder of the paper discusses the seven most important issues which arose from earlier discussion and deliberation. These issues are:

- Computer Acquisition and Support in the Faculties
- Student Access to Computing
- General Time-sharing Services
- Research Computing
- Prototyping Service
- General Purpose File Serving
- Administration of Computing

Following these discussions is a summary and a invitation for you to participate.

Computer Acquisition and Support in the Faculties

Overall this seems to be the most pressing issue to come from the informal discussions... at all levels. Departments and faculties are looking at reductions in capital funding while at the same time are realizing that equipment acquired with capital funds becomes unusable for the primary function in about 3 years. There is some flirting with leasing equipment in a effort to establish a renewal strategy but these require operating funds which require significant compromises in other areas of the departmental budgets.

The net result is that departments buy whatever they can as cheaply as possible when the money becomes available. The result is that there are many different kinds of computers and they each require individual attention of a skilled support person. Also, as these computers age, there is an increasing amount of people support required to keep them in current working order.

The approach we have been discussing is to establish, through the Microcomputer Store, a well defined 'clone' Wintel computer which uses standard components which can be pretested to ensure compatibility. The Microcomputer Store would then preload all of the appropriate software required for campus use. If there are any problems with the hardware or with the software configuration these computers would receive the highest level of attention.

In the future if upgrades were required the Microcomputer Store would have a baseline of the existing components in the computer and would ensure that component used for upgrades would again be compatible.

Under this scheme departments would not need to do 'forklift upgrades', where the entire computer is replaced, but rather would retain as many of the components as possible such as the monitor, hard disk, floppy drive, CD drive, keyboard, mouse, and case. Components such as the CPU chip, memory, and main board would be renewed as required, as could the graphics adaptor and the hard disk.

Vancouver is fortunate in having among the lowest cost of computer components in North America. This scheme would allow us to take advantage of this opportunity. Macintosh computers, since the withdrawal of Motorola from the Mac clone market, cannot be componentized like Wintel computers, although it appears that Apple may be moving towards standardized components and software preloads.

There are two spin-offs from this. The first is that computers with preconfigured hardware and software will require less support at the desktop, and support personnel in the departments will be able to focus more on the departmental needs.

The second is that the computers could be purchased from a combination of operating and capital funds. It is quite conceivable that a monitor purchased today would last 8

years or more as would many of the other components. In this case using capital funds to buy a higher quality monitor would significantly improve the users experience while using operating funds for other component and upgrades would improve the timeliness of upgrades.

Student Access to Computing

The definition of a problem is the difference between expectation and reality.

We currently have a problem concerning students access to computers.

ACS currently has about 400 personal computers available for students to do coursework, research material, read e-mail, and prepare papers. There is also a large amount of personal use of these computers but we will pretend this doesn't occur. With our enrollment of about 15,000 students, each student can, on average, use a computer for about 17 minutes per day. If we reduce the requirement to supporting only our 8,000 full-time students, we can provide about 33 minutes of computer time per student per day.

This is based on an assumption that full utilization of the student computers is 11 hours per day. This comprises 100% utilization during the prime 8 hours of the day and an average of 50% utilization during the remaining 6 hours that the labs are open.

Now comes the reality.

If we wish to increase the number of computers to support the students we are facing a significant financial burden. The capital cost of space, furniture, power, and communications is about \$10,000 per computer and the ongoing operating cost is about \$1,200 per computer per year. Based on these factors the cost of increasing the number of computers by 400 is approximately \$4,000,000 in capital costs and approximately \$480,000 in annual operating costs. This would allow each of our 15,000 students an additional 17 minutes per day. If we were to really go for it and try to provide all of our students with 1 hour per day of computer time we would be faced with a \$12,000,000 capital cost and nearly \$1,440,000 in annual costs.

Enough said?

I've been discussing this issue with people for several years now and the suggested solution, always accompanied by a gulp, is always the same... students should provide their own computers. This sounds onerous until we remember the fact that 82% of our incoming students have access to a computer at their place of residence. We're not really sure if these computers are suitable for supporting the students' scholarly activities but this level of access is a good start.

Pursuing this a little further, there are two obvious approaches to students owned computers. The first is to encourage the students to acquire a suitable desktop computer for their place of residence. The second is to encourage the students to acquire a

suitable laptop computer. There are pros and cons to each of these approaches which are listed below.

The desktop computer approach has several advantages:

1. Desktop computers are significantly less expensive than laptop computers of similar power and capacity.
2. If the preconfigured, pretested component computer strategy is extended to students their life cycle costs could also be significantly less. Students could upgrade the computer just before graduation and leave with a current computer at minimum cost.

The disadvantages of desktop computers are:

1. The desktop computer is not with the student. The student must be at their residence to use the computer. The result is that students will have less time available for computer related activities. Laptop computers can be used during gaps between classes and while studying in the library whereas desktop computers cannot.
2. Students still need computers while on campus... at least for reading and sending e-mail... and perhaps getting some information from the web... and maybe a little looking into the library catalogue... and maybe submitting an assignment or two... etc. We would have to keep our existing computer labs so we could provide each of the students with on campus access to computers... although only 17 minutes per day.
3. Standards and compatibility become more important if a student is to use their own computer for part of a task and use a university computer for the other part of the task.
4. Support is more difficult, as the computer must be brought in to have work performed.
5. File systems are difficult to deliver via slow modem lines. Students with desktop computers will have to resort to lengthy file transfers or removable media to perform software upgrades.

Laptop computers have several advantages:

1. They can always be with you. When you're ready to work, it's ready to work for you.
2. Because you carry your file system with you information you may need is always close at hand, rather than being on a computer at home... which is powered off so you can't even modem into it.
3. Laptop computers are easier to maintain and support because they can be easily brought in for diagnostic consultation and for loading software via high speed network.
4. If students brought laptop computers to campus there would be a reduced requirement for public computers. Laptop computers could be used anywhere on campus and the public spaces such as the study carrels and the concourses would be ideal places to use laptop computers. The public computer labs could be redeployed for other uses.

The disadvantages of laptops are:

1. They are initially expensive and because they are not upgradable the student will have to purchase a second one at graduation if they wish to leave the university with current computing technology. The life cycle costs are very high.
2. The above problem is further exacerbated by the fact that the resale value of used laptop computers is not as high as desktops because they are so easily dropped and damaged.
3. They are more easily stolen.
4. The university would have to provide appropriate infrastructure to support these laptops. The most obvious thing that comes to mind is network connections for laptops in public spaces and study spaces. Classrooms could benefit from network connections as well. Less obvious but significantly more costly is providing electrical outlets at these same locations so students can keep their batteries charged throughout the day.

In the case of either desktop computers or laptop computers, the university would still have to increase the size of the student modem pool. The cost of a modem and line is \$1,980 per year which is higher than a lab computer at \$1,200 annual cost. However there is a charging policy in place which would recover some of these costs. Also the capital cost of modems is very little compared to the capital cost of computer labs.

General Time-sharing Services

It is time to finally drive a stake through the heart of centralized computing by eliminating general purpose time-sharing.

Time-sharing was developed years ago when computers were so expensive that they had to be shared. Very complex operating systems were developed to make each user of the system think they had their own computer. Multiprocessing was a term used until 10 years ago to mean multiple tasks running simultaneously on one processor. Now multiprocessing means one task running simultaneously on multiple processors. In more recent years time-sharing systems were utilized to gain access to software packages which only ran on large centralized time-sharing servers. This situation has also changed over the last 5 years as all but the most specialized software packages are developed first for the personal computer and later (if ever) appear on time-sharing systems.

Why should time-sharing be eliminated?

1. Currently the processors in our time-sharing systems have little if any performance advantage over the processors in many of the personal computers, but the complexity of the environment and the attendant overhead of balancing their performance, providing high speed links to their files, monitoring their security, and maintaining their operating systems, make them very costly relative to their performance.

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2. Everybody who is accessing the time-sharing servers is doing so from a personal computer which generally is already more powerful than the share of the time-sharing server they are going to utilize. Time-sharing users must also acquire, configure, and use a program which turns their state of the art, high performance, personal computer into a dumb terminal utilizing rudimentary technology developed 30 years ago. This technology is not helping anyone move ahead... and it may be holding many back.

Why are we still using time-sharing systems?

Electronic Mail!

People who generally use only one computer have almost all switched to Eudora for accessing mail and don't use the time-sharing to access mail. Time-sharing is primarily used to access mail via ELM or PINE by people who have either no computer or more than one computer.

While Eudora has been phenomenally successful with a large number of users it has one big disadvantage. This is that it sends all e-mail to the personal computer. If the user wishes to keep the mail they must store it on the personal computer. If they share a computer, such as a lab computer, they have few options for storing their e-mail. Another problem is if the user has several computers, such as one at home and one at the office, they have some management problems with where mail is saved and which mail has been dealt with.

ELM and PINE, on the other hand, keep all of their mail on the centralized file system regardless of where it is accessed from.

Is there a solution to this mail problem?

There is an emerging mail protocol called IMAP4 which has been developed to overcome the problems listed above. Mail clients using the IMAP4 protocol combine the best of personal computer based mail such as Eudora and central computer based filing like ELM and PINE. The best known IMAP mail client is the new NetScape browser 'Netscape Communicator'.

Using the IMAP protocol has several other advantages:

- It works very well with low speed connections.
- It handles group mailing very well in that it only stores one copy of the message. This would enable messages to be sent to the entire community without unduly filling the mail system.
- It allows rich content and formatting via multimedia extensions. Anything that can be put in a web page can be put in a mail message.

Research Computing

It has come up in discussions that there is a perception of an imbalance in support of research vis-a-vis research requiring networking, communications, and collaborative computing is well supported, while research requiring large volumes of data or intensive computing is not well supported.

The research server 'Beaufort', which is a little over 2 years old, can now be outpaced by a fast Pentium processor. Beaufort is used by a large number of people for processing mail but this is a relatively light load. The majority of cycles are consumed by Physics and Economics. These are the researchers who need more compute cycles.

Our discussions in this area centre on trying to take advantage of the inexpensive cycles in consumer computers. The approach here would be to build a cluster of standardized, identical Pentium class computers which can be used in parallel operations or more loosely coupled in simultaneous computing. The benefits of this approach are:

- we minimize the cost of hardware by acquiring consumer grade products.
- we minimize the cost of support by having identical hardware and configurations.
- we minimize the cost of upgrades through component level upgrades.
- we maximize reliability through redundancy.
- we minimize the cost of increasing demand by acquiring more rather than bigger

Prototyping Service

The nature of the technological environment has changed greatly for many of our users as it has those of us in ACS. Many of our users also have to research, develop, and deliver services to their end users via network based distributed computers. Many are web servers but there are others, such as the First Class servers. We anticipated this several years ago, and when we renewed our infrastructure servers we acquired a reasonably large web server, thinking that this could provide a basis for a web server that could support applications from across the institution.

We have succeeded in providing a robust production environment for installing web pages and CGI scripts. However, we have not succeeded in providing a facility that would allow people to test new technology, prototype new services, and transition to a 'production' service where appropriate. We need to provide servers and expertise to assist experimentation, without compromising our current production environment. This means that we have to take into account that the services being tested:

- rarely have mechanisms for keeping files private from other applications.
- often require the manager of the application root access to the server.
- there is no mechanism for protecting application's failure from effecting others.

We have had discussions with several people about such a facility but we don't have the hardware to accommodate them adequately. Currently our web services are provided

through SUN servers running unix and while it is relatively easy to 'clone' the server for test purposes the \$25,000 - \$30,000, price tag seems to have a dampening effect.

The approach we have been discussing is to build and configure Pentium based servers which are inexpensive (currently about \$3,000) with known standardized versions of both unix and Windows NT available. These servers could be assigned to individuals or groups to prototype and test their applications without interfering with either our production services or with other users testing applications. As these prototypes become more 'production' than R&D, they may stay on the individual server or they may migrate to other more appropriate servers.

The trick to making this a cost effective service is to keep the ACS system support costs to a minimum. This is done by replicating the operating environment across all of the servers and maintaining them all in parallel.

It is in the area of prototyping service more than any other that we really require a partnership arrangement with our users. Often we are both on a learning curve and the relationship cannot be managed by the practices and procedures of a production service.

General Purpose File Serving

File servers were developed when the cost of disk storage was very high but the cost of processors and workstations was declining. This was also a time when operating systems were very complex and the average user could not maintain their own computers.

File servers made it possible to take advantage of economies of scale by purchasing a small number of large hard disks and sharing them among a large number of people. The 'Network File System' made the shared disk located remotely from the workstation appear as a private disk local to the workstation. This also enabled some centralized management of systems by storing shared programs in one place rather than installing them separately on each user system.

Again things have changed in several ways. The first is that while inexpensive high performance computer chips have made computers cheap the technological advances which allow computers to move large amounts of data quickly have been much slower in coming. The second is that large capacity hard disks have become a consumer item and are now available very inexpensively. The advantages commercial grade disks have over consumer grade disks are primarily speed, reliability, and price... not capacity.

Unfortunately file servers are required to move large amounts of data quickly and, relative to workstations, are still reasonably expensive. If you add to this the costs of server software and the costs of highly skilled systems administrators to manage these complex systems the savings may not be there.

The Auspex file server supporting our central unix time-sharing systems and a number of individual workstations on campus currently holds files for the systems themselves as well as the files of 21,000 users. It serves up to 100 computers simultaneously and up to 600 users simultaneously. The performance of this server is such that it can do all of this and still look like the disks are actually attached to the computers. The reliability is such that we've experienced only 2 hard disk failures in 7 years! Recently had to restart the computer because it had run without interruption for over 250 days, which it is not designed to do.

We think this is impressive but the other side of the story is that it currently costs about \$1.60 per megabyte if we purchase it in \$85,000 units. This doesn't scale up well. As a comparison the cost of consumer grade hard disks can be as low as \$0.12 per megabyte in \$250 units. As a further comparison recordable CD's cost about \$0.02 per megabyte in \$10 units, although this doesn't include the cost of the recorder. All this to provide faculty members and staff with \$24.00 of disk space and undergraduates with \$8.00 of disk space. The value of this storage if they were to purchase their own disks could be as low as \$1.80 for faculty members and \$.60 for undergraduates.

The main reasons that we need this big, expensive, high performance server are twofold:

- serving the centralized time sharing servers.
- serving students who are sharing computers in the student labs

If we can eliminate time sharing, as previously discussed, and if students use their own computers, as previously discussed, we've eliminated the main reasons to continue with this approach to file serving.

Freed from these requirements we could adopt a strategy to provide file serving in a more appropriate, less expensive, and more scalable manner. We should focus on providing services that cannot be cost effectively provided elsewhere. Also I must reiterate the need for scalable solutions because disk space requirements are going to grow phenomenally for the foreseeable future and we are going to be unable to meet the demand with our current strategy.

The Discussed Approach

The approach we've discussed is to provide services to take advantage of positive attributes. These are:

- Our systems are very reliable
- We are at the centre of the network
- Our services are secure
- We have backup facilities
- We have people to answer phone queries, perform backups, diagnose failed systems, and call for help when required.

As our community of users becomes more mobile they will require facilities with these attributes that can house and deliver information 24 hours a day while they are working with their computer in the library or at an archaeological dig site. As another example

instructors doing on-line teaching have enough work interacting with students, modifying the material, developing the next course, plus doing their research and the unavoidable institutional administrivia. They need a haven where the work they've completed can be reliably maintained and delivered to their students.

Our focus would be to provide multiple medium performance, high capacity, reliable, secure storage servers based mainly on consumer grade products at consumer level prices. These servers would all be identical, would be interchangeable and would be designed with appropriate redundancy to achieve the reliability we require.

Administration of Computing

The administration of our computing facilities has become more critical as computing has become more critical to our community. The modem issue has become very public but there are many less public administrative issues which are of significant importance. The following are three that I would like to touch on:

Encryption/Authentication Service

Privacy and encryption are becoming an important issue and we are beginning to receive queries from users about this. Current encryption technology is based on public key encryption where each user has both a public and a private key. This is not the place to describe Public Key encryption but it is important to know that the cornerstone of Public Key encryption is knowing, with a high degree of assurance, what a person's public key is. This is a significant security and information management problem and there are a number of schemes for this ranging from asking a number of people you trust to authenticate someone to asking a trusted certificate authority to authenticate someone.

We have been discussing including with our directory services a facility for checking and maintaining the public keys for those members of our user community who wish to use encryption facilities.

Distance Accounts

This subject pertains to people who use our facilities from a distance. This includes people who are always remote such as distance education students and research collaborators at other facilities as well as those who are trying to use our facilities while travelling out of town.

The problems surround our need to positively identify people before giving them an account and even more so while resetting passwords or helping them gain access to accounts.

In the past we have been more relaxed and allowed ourselves to be persuaded by a husband with letter from his wife stating that she was sick, couldn't come in, and would we please reset her password and give it to the bearer of the letter. We did so.

Several months later we were approached by the RCMP from Calgary regarding this account. Apparently the person we had given the account to was not her husband and he had been monitoring her account in order to stalk her from Vancouver, to Edmonton, to Calgary where he was apprehended. Since then we have been extremely rigorous in positively identifying people before issuing and resetting passwords.

We are not proposing a solution in this discussion paper but rather are acknowledging that it is an important issue and that it is one of the administrative tasks which we have to address as we move forward.

Alumni Accounts

I have received numerous requests for accounts for alumni. Students who have used SFU's computing facilities often would like to continue to do so. It is possible for them to do so but they have to pay for their account as external users.

Other universities, Yale among them, have issued e-mail accounts to their graduating students and have seen the following benefits.

- Many graduating student get e-mail accounts at their place of work when they are employed... then they change employers.
- With an alumni account the students use the e-mail address as a forwarding address to their place of work. This has two benefits.
 1. The students can always be reached by their fellow students and friends.
 2. The graduates, on their business card, have an e-mail address of the form 'janedoe@alumni.yale.edu'
- The graduates do not feel they are cast adrift when they graduate.
- The development office finds it much easier and cheaper to keep track of students once they graduate.

Our discussions are focusing simply on providing an e-mail drop with web page access to changing forwarding addresses and IMAP4 or Eudora access to sending accessing e-mail. These would be very inexpensive services to provide. If the alumni wished to use the modems to access the accounts they would have to purchase access to the premium modem pool.

Summary

The following is a summary of the above discussions placed within the context of the initial three questions.

1. What should we quit doing?
 - General time-sharing should be eliminated.
 - General purpose student labs should be phased out.
2. What should we start doing?

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- Provide preconfigured, pretested, component based computers through the Micro-computer Store to reduce faculty and department acquisition, upgrade, and support costs.
 - Provide more facilities which allow students to integrate their own computers into our environment.
 - Implement a Prototyping Service for network applications builders and testers.
 - Enhance the administrative functions of Academic Computing Services
3. What should we do differently?
- Research Computing
 - General File Serving

Invitation for Comments

Many of the technology committees in which I've participated have scheduled open meetings to seek input from the community. Generally the turnout for these meetings has been between none and poor. Frankly, I don't think this discussion paper will generate any improvement in attendance at an open meeting and for this reason I'd like to try a different approach.

If you would like to talk about any of these issues, or any others, I will make it my highest priority to meet with you at your earliest convenience. Better still, if you and several of your colleagues would like to discuss things as a group I would be pleased to meet with you. I'll make every effort to attend any departmental meetings, faculty meetings, computing committee meetings, or any other meetings to which I'm invited.

If you would prefer to chat on the phone my number is 291-3570 and if you would rather send e-mail my account is lionel@sfu.ca.

I reiterate the question... What can we do to make you successful?

Your input is important!

Appendix 1: Current Services & Facilities

Distributed Services

- Documentation & Training Services
- Prepare, publish, and distribute Computing Services documentation.
- Preparation, publish, and distribute the Focus newsletter.
- Develop and deliver the non-credit computing tutorials.
- Develop multimedia user assistance material.
- Provide the Help Line.

Drop-in and Instruction Labs

- Microcomputer Facility.
- Shrum Facility.
- The Wordstation.
- West Mall Instructional Lab.

Assignment Labs

- East Concourse Assignment Lab.
- Install and support the software on behalf of the course instructors.
- Manage assignment lab accounts for students.

Desktop Computer Support

- Over 5,000 computers supported.
- Personal computer consulting.
- Network installation & configurations.
- Site licenses for widely used software such as SPSS and Systat.
- File & print server.
- Public printers.
- Departmental printers.

Departmental Networks

- There are currently 29 Novell based departmental networks.
- Varying levels of support required.
- Provide expert level support.
- Assist with installation and administration of the departmental servers.
- Provide troubleshooting assistance.
- Liaise with the software vendor.

Harbour Centre

- Personal computer labs.
- User assistance.
- Network support.

Network Infrastructure Services

- Authentication & authorization server.
- E-mail server.
- Mail directory server.

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- Netnews server.
 - Web server
 - CGI server
 - RealAudio server
 - High speed campus network
 - BCNet, RNet, CANARIE, CANARIE II, Internet, Internet II connectivity
 - Modem pools.
 - ISDN Modems.
 - Rogers Wave liaison.
 - BCTel ADSL liaison.

Unix Cluster Services

- Large scale server
- Research server
- General server
- UNIX file servers

Machine Room Services

- Secure, air-conditioned, clean power facility.
- Staffed 6 days per week 24 hours per day.
- Network monitoring.
- System backups.
- Routine administrative programs.
- Initial problem diagnosis.
- Problem resolution coordination & monitoring.

Administrative Information Systems Services

- Administrative Systems Servers.
- Low speed communications network.

Administrative & Internal Support Services

- Microcomputer Store.
- Account & password administration
- Modem charging
- System security
- External services
- Staff training