

TECHNICAL PAPER

**Predicting Areas of Need for
Computer Technology at UCM
During the Next Five Years
(2001-2005)**

by

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prepared for

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Predicting Areas of Need for Computer Technology at UCM During the Next Five Years (2001-2005)

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version 2

Everyone understands there is a real and growing need for computer technology at the Catholic University of Mozambique. As soon as full-time access to the Internet becomes easily available, the “growing need” will quickly change to an “explosion in demand”. It will extend to every faculty, and it will extend to almost every activity of the university. Experience from other universities allows prediction of what will happen at UCM. The comments below pertain especially to the Faculty of Medicine and Biomedical Sciences at Beira - Palmeiras and the Faculty of Economics and Management at Beira - Ponta Gêa. Some comments may also be useful for other UCM campuses.

Additionally, at the end of this document there is a section titled “Technical Considerations”, with comment upon the Ethernet maximum wiring limit of 100 meters. As a consequence, there is a suggestion to place servers and computer labs in a central location within the building.

Expand the present computer center and staff into a “Technology Center”. Such a center could handle all aspects of computer hardware and software, network servers, repairs, education of “users”, and possibly the setup and maintenance of laboratory and other special instrumentation. The center could support both Beira – Palmeiras and Beira – Ponta Gêa campuses. This will require a budget and small permanent staff, supplemented by part-time student help. The permanent staff may need to be 3 people at the beginning, and expand to 4 or 5 by year five. It will be important that at least 2 people are involved with every important activity, in case someone leaves unexpectedly. It will also be important to establish a tradition of “sharing” and “passing along” useful knowledge. For example, electronic “Technical Notes” could be prepared which describe an activity, and should include designer comments, how to actually do it, lessons learned (ie, what *not* to do next time), and other tricks and tips. Such information will even be helpful to the author, when she/he tries to remember what worked just a few months earlier. And it will be invaluable to anyone else.

An important activity of the Technology Center must be “re-education”. The Technology Center staff, no matter how large, will *never* be able to do everything for everyone needing technology. But there is every expectation that the staff can learn how to do things at the beginning and then teach others how to do it themselves from then on.

The Technology Center will probably need to be involved in these activities:

- Develop and make available instructions for students and staff on how to use the computer lab and equipment, how to “log-in” and “log-out”, how to send e-mail.
- Provide a telephone and/or e-mail “Help Desk” for students and staff providing answers to technology questions and problems, and to help “walk a person” through a solution.
- Provide workshops for students and staff on topics such as how to set up a PC for use with the UCM network, how to use the Internet, Web, Word, Powerpoint, Excel, how to use a video projector.
- Setup and maintain the various computer servers – network server, Web, and eventually mail and distance education servers.
- Handle the repair of computer hardware by means of swapping major components, such as motherboards, and disk drives.
- Handle the repair of operating system and application software, possibly by providing “do it yourself” instructions for students and staff, along with access to installable versions of software that can be downloaded from a UCM network server.

- Handle software license issues – arrange for free and academic versions of software, site licensed software.
- Continue to expand wiring of the campus for connection with the UCM Local Area Network (LAN) and full-access to the Internet.

Technology Services for Students and Staff. Every entering UCM student and staff should automatically receive a computer “account” and “password” (ie, hard disk space on the server for their personal use) so that they may use all the various university network computer services. These services should include access to the Internet, the World Wide Web, and a personal e-mail account. Eventually everyone should be able to have a personal web page. These services could even be provided for a few years after students graduate.

Computer Labs. Two computer labs, having perhaps twenty machines, will be necessary at each campus. Every computer should have connection to the UCM network, the Internet and Web. There should be a laser printer in each lab. It would be desirable if there is a scanner and CD-Writer capability. One lab should be equipped with a video projection system and might be reserved occasionally by staff for classroom computer-related instruction. The other lab should probably always be available for individuals to use throughout the day, evening, and eventually weekends. There will no longer be need for a separate “staff only” computing lab, since every computer will have network and Internet connection. Sensitive materials, such as exams, may be prepared in the staff member’s own office. Also please see comments below about wiring and location of the labs.

Electronic Library. Every computer in the library should have a connection to the UCM network, Internet, and Web. Since more and more library materials will be obtained on CDROM, it is suggested that the library should also have a CD-Writer and large supply of CDR media. Original materials on CD may then be copied with the CD-Writer and only the copies made available for circulation.

Offices of Faculty, Staff, and Administration. As previously stated, every computer should have a connection to the UCM network, Internet and Web. Every computer in the office of a member of the faculty, staff, or administration also needs a laser printer and uninterruptible power supply (UPS).

Expand the Office of Development and Grants. This office will lead the way toward funding of new technology by writing competitive grants. In particular, this office could help:

- Nurture and coordinate efforts for institutional fund-raising.
- Nurture relationships/ partnerships with other academic institutions from around the world, especially Catholic-related institutions.
- Nurture relationships with organizations with similar interests in community outreach – such as Rotary International, Lions Club, Peace Corp, and the various NGOs.

Establish an “Office of Public Relations.” The new technology provides an opportunity to handle public relations and alumni relations in an entirely new way. This new office might:

- Provide periodic alumni news and alumni information through the UCM web pages. New graduates might continue to be provided a UCM network account for several years after graduation.
- Develop a special newsletter for each Faculty – with features such as new curriculum developments, spotlight on faculty and staff, spotlight on exceptional students, spotlight on successful graduates.

- Develop a traditional mailing list and electronic mailing list of “friends of UCM” receiving these newsletters. For example: the Minister of Health and most physicians in Beira and Maputo could receive a Faculty of Medicine Newsletter.
- Maintain an electronic guest book with visit dates, photos, contact information (e-mail, telephone, FAX, mail address) – for internal use by UCM. Such information could be added to a Password Protected zone of the UCM Web. This would make such information easily available to staff. It would also be nice to send visitors a copy of digital photos, press release, and other results of their visit.

Expand the UCM Network into Classrooms and Laboratories. At minimum, the university should plan to equip one classroom, lecture demonstration room, or seminar room with a video projection system. Such a system consists of a computer, color video projector (possibly mounted from the ceiling), projection screen, laser pointer, window curtains, and variable intensity room lighting. It should include a connection to the UCM network, Internet and Web. In future, additional classrooms and laboratories may be wired. These rooms could be served by a portable computer and video projection system on a cart obtained in a future year.

[cost estimate - US\$ 10,000 (includes a spare long-life projector bulb @US\$ 900)]

Administrative Services. The University will need to computerize its student records, billings, admissions, and payroll. A few companies sell and support special software for this purpose. Before buying anything, please talk to and visit a university already using the same system.

Establish a capability for “Distance Education.” Initially, this will require one network server and course management software – such as WebCT, a popular Canadian product. With only a half-day workshop on how to use such software, even non-computer-expert staff will be able to place materials onto the server for support of any course. Students view course materials using the Internet and regular web browser. Such course management software provides support for taking exams on-line, for chats, whiteboards, the posting of assignments, sending in assignments electronically, and obtaining grade results. Initial use would be to provide web-assistance for regular on-campus courses. A second phase of activity would involve development of complete stand-alone web-based distance education courses. That is much more challenging. However, many universities provide an incentive grant (perhaps US\$ 500 or more per course) to staff willing to engage in such activities. Another approach is to also use/ adapt courses developed elsewhere – possibly by institutional partners. Right now a technical concern is the low “bandwidth” (ie, slow connections) available in Mozambique. That problem will gradually resolve itself over the next few years. In the meantime, distance education courses can be created in a way that encourages “off-line” work from a CD sent to a student through the ordinary mail, and reserve “on-line” for the chats, exams, and getting grades.

[cost estimate - US\$ 6,000 initial cost for equipment and software, plus incentive budget of US\$ 3,000 per year (6 course @ US\$ 500)]

Faculty of Medicine and Biomedical Sciences

The Faculty of Medicine and Biomedical Sciences has plans underway to build an on-campus UCM Health Clinic. Those plans might be modified to include additional space to:

Establish a “Health Technology Resource Center” as a part of the UCM Health Clinic. This activity should begin at first opening of the Health Clinic. It would probably require three rooms. This center would be equipped for training practicing medical professionals as well as medical students in every aspect of a modern health clinic. It could cover topics such as how to use modern analytical instruments and testing, use of a computer for keeping patient info, software on drugs/ treatment, software which helps diagnose a patient, how to use web for e-mail, web-based health resources, modern drinkable water system,

tools/ glove sterilization and sanitation. Workshops would be held for staff from rural clinics being upgraded with similar technology. The UCM Health Clinic should have a connection to the UCM computer network, and this could be extended into the Health Technology Resource Center.
[cost estimate for clinic resource center - US\$ 100,000 for equipment, supplies - plus yearly budget of US\$10,000 for upgrade and maintenance, plus budget for support staff (1 or 2 people?)]

Expand Distance Education to include “Health Care” courses. Such courses will be designed for practicing physicians, nurses, and other health care workers. The course materials will be available on the web using a regular browser. These activities could begin anytime, and might be introduced as part of the Workshops given at the Health Technology Resource Center. The course materials might be obtained free from institutional partners.
[cost estimate – almost nothing, assuming that the UCM Technology Center has already added the distance education capability]

Begin a “Telemedicine” Capability as a part of the new UCM Health Clinic. This activity could begin sometime before the first UCM medical students have graduated. It would probably require one or two rooms and could be an extension of the “Health Technology Resource Center.” Initially the telemedicine capability could be web-based, having good sound quality and poor quality color video. It might also include a low-cost microwave system capable of video, audio or Internet (up to about 15 kilometers distance), currently costing about US\$ 10,000. The technology resource center staff could watch for, purchase and evaluate lower cost *emerging* technology as it becomes available. They could also work closely with the Office of Development and Grants to obtain funding for equipment/ supplies for rural health clinics. Workshops/ short courses for rural health nurses and physicians might be presented as clinics receive such technology.
[cost estimate - US\$ 25,000 for equipment and supplies to get started. Assume all later funding by grants.]

Faculty of Economics & Management

The Faculty of Economics and Management is just starting a new Masters Program. The success of this program will be enhanced by additional technology, in particular:

Establish a “Small Business Technology Resource Center.” All students in Economics and Management really should have an intimate knowledge of current technology necessary to efficiently operate a business. This goes far beyond simply using a computer in a UCM Computer Lab. The envisioned Resource Center could support a first phase of activity - much needed hands-on/ laboratory environment. It could contain a small network of desktop computers (5?), laptop computers (2?), network server, Ethernet network hub/ wires/ network interface cards, shared printer, scanner, graphic tablet, video projection system, computer cash register with cash drawer and product bar code reader, video surveillance equipment, color laser printer, digital camera, CD-Writer, and a variety of business software. The Resource Center would be used for UCM classes/laboratories and for a series of evening/ weekend Workshops for area business people and employees.

The purpose would be twofold: 1) to see and become familiar with such technology, how it is utilized, and how it can make a company more efficient, and 2) to learn how to setup/ install, maintain such technology.

Most business owners and managers will be naturally drawn to this Center. They already understand that they need to know about new technology – they just need help getting started. This Center will provide a unique place where UCM students and professors get to know and work with business people. Additional spin-offs will include internship opportunities, and GEA..Consult opportunities. We predict a large increase in company donations to UCM and the Faculty of Economics and Management as a direct result of having this Resource Center.

[cost estimate - US\$ 50,000, plus yearly budget of US\$ 7,500 for upgrade and maintenance, plus budget for 1 additional technology support staff]

Second Phase. The Small Business Technology Resource Center should be expanded to include electronic commerce. This simply involves running Web Server software on one of the computers already in the Center. The Microsoft Personal Web Server even comes free as part of Windows 98. Workshops could be presented on topics such as “Getting Started Using the World Wide Web in Mozambique”, “Creating a Business Web Page”, “Opportunities for Electronic Commerce in Mozambique”. There could be a full semester course on “Electronic Commerce” aimed at senior undergraduates or Masters level.

Third Phase. The final step would be to add courses such as “Business Information Systems”, and “Software Development for Web Applications” (Visual Basic, JavaScript, DHTML, etc.). This could eventually lead to the creation of a “Computer Information Systems” (CIS) emphasis within the Faculty of Economics and Management or possibly even to a stand-alone program of study. Alternative, related programs to consider might be “Information/Web Technology Management”, or even “Web Network Engineering”.

Expand Distance Education to include “Economics and Management” courses. Such courses will be designed for business persons from the community. The course materials will be available on the web using a regular browser. These activities could begin anytime, and might be introduced as part of the Workshops given at the Small Business Technology Resource Center. The course materials might be obtained free from institutional partners. Such courses could be equivalent to regular on-campus courses. UCM could also provide non-academic “training” types of courses for businesses.
[cost estimate – almost nothing, assuming that the UCM Technology Center has already added the distance education capability]

Technical Considerations

Ethernet versus Fast Ethernet. The current UCM network wiring is traditional Ethernet, often referred to as “10BaseT”. We say it aloud as “ten base tee”, where the “10” designates a speed of 10 megabits per second over baseband (“Base”) using twisted (“T”) pair wire. The cable contains 8 wires terminated with telephone-like, RJ-45 connectors.

A newer version is termed “Fast” Ethernet, or “100BaseT”. Here the speed is 100 megabits per second, or ten times faster! Both technologies are mature and reasonably priced. Since the price of Fast Ethernet is only slightly higher than traditional Ethernet, it makes good sense to move to Fast Ethernet. The required network cable (comes in a variety of colors) and connectors are designated “Category 5” cable and Category 5 connectors. Fortunately, the existing network cable at Beira – Palmeiras is already Category 5 and this may be reused within the new network.

All wiring can be handled by UCM staff. They will need a few rolls of wire, a connector crimping tool, electronic cable testing tool, and a bag full of connectors. They will also need electrical channel into which the cables run, along with the ability to drill a few holes through concrete.

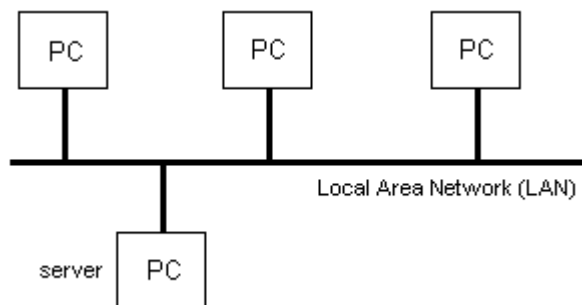


Figure 1. Typical Local Area Network (LAN).

A typical local area network (LAN) connection is shown schematically in Figure 1. The physical connection, Figure 2, shows more details – a central Ethernet port concentrator, or “HUB”, wires, and Network Interface Card (NIC) installed in each computer. This LAN is all by itself. With a few accessories, however, it could be connected to other networks or even the Internet.

The HUB is available in sizes of 4 ports, 8, 16, or 32 ports. Each HUB requires electrical energy. HUBs are available for 10BaseT, 100BaseT, and combined 10/100BaseT. They also come in various models and prices, from “simple” to “smart”. All HUBs have the same basic capability. The smart HUB provides easier troubleshooting from the computer center by running diagnostic software. In order to check a simple HUB, a staff person must walk to the location of the simple HUB and directly observe diagnostic lights on the HUB front panel and decide that it is still working. **At UCM a good choice would be “simple” 10/100BaseT HUBS (with perhaps 16 ports) capable of handling both 10BaseT and/or 100BaseT.** This way, both older and newer, faster equipment works. Future purchases of Network Interface Cards should all be of the 100BaseT type with RJ45 sockets.

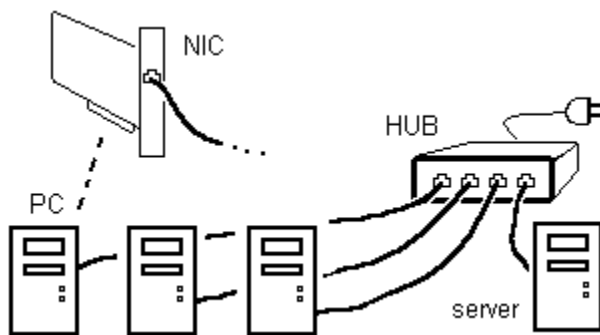


Figure 2. Typical LAN showing connection details.

There is a maximum distance of 100 meters for any single segment of Ethernet cabling. For cable runs longer than 100 meters, an additional HUB (or a similar device called a Repeater) must be installed, otherwise the signal is weak and communication is not reliable. For this reason, the best network design places servers and HUBs centrally located to keep runs as short as possible and within the 100 meter limitation. This keeps the wiring costs to a minimum and the network performance high.

At UCM Beira – Palmeiras, this means that the current computer center and labs on the end of the second floor should be relocated to a more central location. A good choice would be rooms 104, 105 and 106 on the first floor. The space made available on the second floor might be returned to classroom use. That space could eventually provide room for future expansion room of CIDD and GIS.

This network wiring scheme permits every computer to have access to the network server (“client to server”). Every computer also can access every other computer (“peer to peer”). Every computer would have Internet connection and access to the Web. If the server is not working (“down”), any computer can still see and communicate with any other computer on the UCM network. Furthermore, if the server is not working, any computer can still access the Internet and Web.

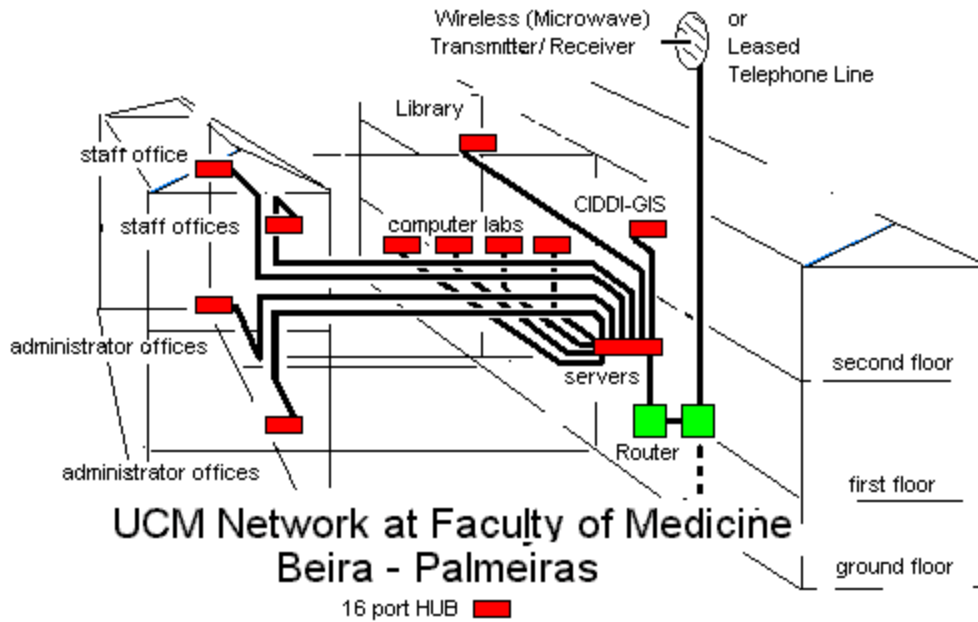


Figure 3. UCM Network at the Faculty of Medicine - Wiring.

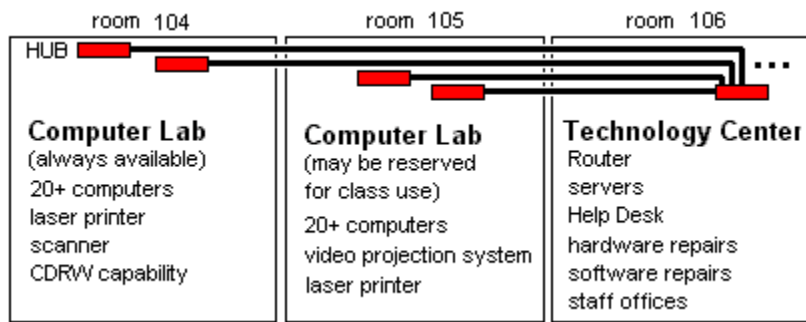


Figure 4. Faculty of Medicine – Computer Labs and Technology Center.

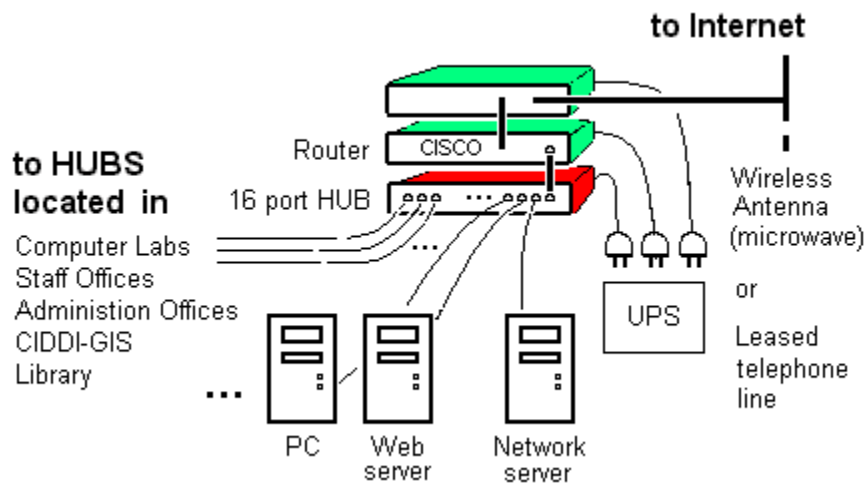


Figure 5. Faculty of Medicine – Server Connections.

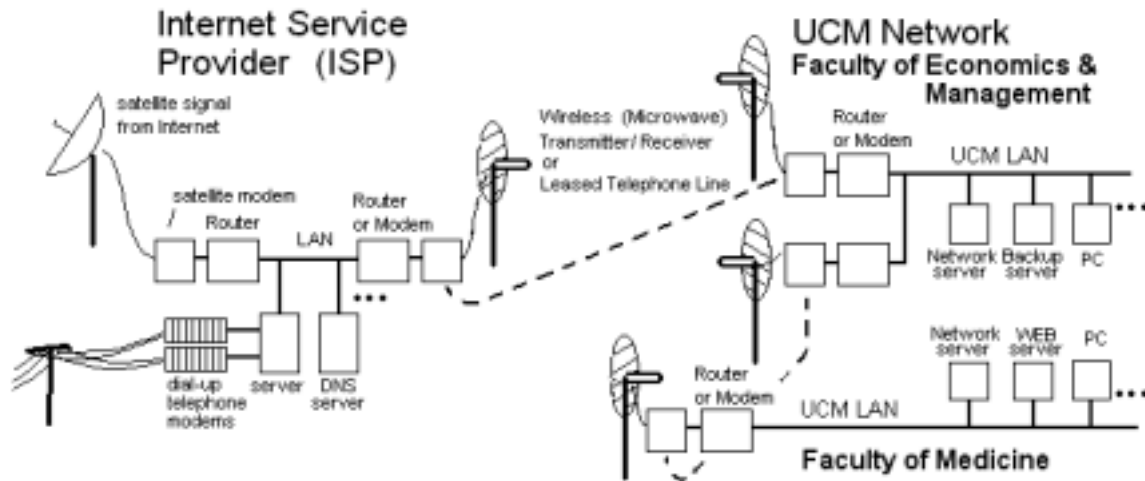


Figure 6. The UCM Network will have a full-time connection to the Internet Service Provider (revised).

UCM Network Servers – can be added during four phases.

Phase 1 – Year 1 (a total of 4 servers). UCM will begin with a minimum of 4 Pentium computers. Two could be located at the Faculty of Medicine and two could be located at the Faculty of Economics and Management. They may run Microsoft NT Server operating system, the newer Windows 2000 Server, Unix, or some combination of these. The Microsoft products are suggested because they are the easiest operating systems to install and maintain.

The Internet Service Provider (ISP) company will handle domain name services. In particular, the Internet Service Provider will apply for and obtain a unique “domain name” for UCM, such as “ucm.mz” along with a web address of “www.ucm.mz”, or some other appropriate addresses. The ISP will be the “virtual host” for UCM using these addresses.

Server Hardware. Recent model Pentium computers will be adequate for servers. It is *not* necessary to purchase the high cost heavier duty “server PC” with hot exchangeable power supply and drives. But there must exist a backup computer ready during times of servicing and troubleshooting. It is desirable (but not necessary at the beginning) if hard drives could be the SCSI type – for dependability and because that interface supports more than 2 drives on a single computer.

All the computers, HUBs, Router and other equipment should be connected to Uninterruptible Power Supplies (UPS).

Wiring during year 1. Cables should run from computer center to both computer labs, to all staff offices, and to one seminar room or classroom.

Main Server for the UCM Faculty of Medicine LAN (suggest a computer name of “ucm1”, possibly at address `ucm1.ucm.mz`) – running 24 hours per day.

Main Server for the UCM Faculty of Economics and Management LAN (suggest a computer name of “ucm2”, possibly at address `ucm2.ucm.mz`) – running 24 hours per day.

Web Server (“ucmweb”, possibly at address `ucmweb.ucm.mz` and www.ucm.mz – running 24 hours per day. Probably located at the Faculty of Medicine, and serves everyone.

Backup Server (“ucm3”, possibly at address `ucm3.ucm.mz`) for both Main Servers and Web Server. This server should contain a duplicate copy of everything on the three servers. Backups could be performed daily or perhaps every few days. This server would be the first computer for installing and testing new services. Once things are working properly here, the new services are transferred to the main server. Probably located at the Faculty of Economics and Management.

Phase 2 – Year 2 (total number of servers grows to 6). During this phase there could be two additional servers added for administration records and a backup. A “firewall” (special software and possibly some hardware) should also be added for protection against uninvited, potentially harmful visitors to the UCM network.

Administration Records Server (“ucmadm1”) – runs during business hours.

Backup Administration Server (“ucmadm2”) – runs during business hours.

These servers should have multiple SCSI hard drives along with a “removable” hard drive for backup. Backups should be performed twice a day by copying from one drive to a second drive. There should also be a removable hard drive that can be physically stored at a separate location – perhaps in a different wing of the building in a fireproof safe. If possible, add additional SCSI hard drive space on “ucm1” and “ucm2” to accommodate more student and staff accounts.

Wiring during year 2. Add lines to one more classroom and one laboratory. Also consider adding a line to the cafeteria, where a few computers could be placed for easier access during breaks.

When the UCM staff apartment building is being planned, please include an additional network run into each apartment.

When the UCM Health Clinic is built, please include a run to the UCM network.

Phase 3 - Year 3 and 4 (total number of servers grows to 9). During this phase there could be two additional servers added for Mail and for Personal Web pages, along with a Backup Mail/Web Server.

Mail Server (“mail” at possible address mail.ucm.mz). Now everyone can have a personal e-mail account. Runs 24 hours a day.

Personal Web Server (“webpage” at possible address webpage.ucm.mz and www.webpage.ucm.mz). Runs 24 hours a day.

Backup Mail-Web Server (“ucm4” at possible address ucm4.ucm.mz). This server might also serve as a backup for the Main Server at the Faculty of Economics and Management.

Wiring during year 3 and 4. Run cables to all the rest of the classrooms and laboratories. The wiring of the building will then be completed. Add a line to the new UCM Health Clinic when it has been completed.

Phase 4 – Year 5 (the total number of servers grows to 11). During this phase UCM will become less dependent upon the Internet Service Provider (ISP). UCM will continue to pay for Internet “access”, but will begin providing its own domain name service. This requires a Domain Name Server and Backup Domain Name Server. UCM can work closely with the ISP during the transition.

For the last ten years the author was Professor of Computer Science at Marshall University, Huntington, West Virginia USA. Recently he left academia to pursue consulting. His projects have ranged from the development of new laboratory instrumentation, computerized data collection and analysis, to developing distance education courses in the areas of World Wide Web and Visual Basic Programming. During January – March, 2001, he assisted UCM as they established their first web site. He may be reached at:

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