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Executive Summary

Uninet is a project of the Foundation for Research Development (FRD) and its management office is situated in Pretoria. The members are technically participants because they participate in the project. Its initial objective was to provide a focus for the networking efforts of the research and academic community in South Africa. As part of this objective Uninet Office has installed and runs a network of circuits and routers.

There are 51 South African participants who have formal agreements with the FRD for this participation, and 4 countries from the SADC region have similar agreements. There are 8 schools that route their Internet traffic directly via Uninet connection using TCP/IP, three school network groups that do the same, and an unknown number of schools that have TCP/IP connectivity into Uninet via the interior networks of Uninet members (estimated at between 10-20). An unknown number of schools dial into either the school network hubs or into Uninet sites themselves (estimated at around 200). Connections by schools are currently
on a "best effort" basis. The Uninet Office does not have the resources to handle it in any other way.

The Uninet board is a ten-member policy advisory body overseeing the operation and expansion of the network. With a small operational team of three, the network is resourced in such a limited way that it relies heavily on the collaborative input of the various member institutions, as was intended from the original design.

Increasing demands on national and especially international bandwidth from advanced multi-media and other bandwidth-intensive applications used in education and research have placed Uninet in a difficult budgetary situation: while 1995/96 charge levels to the member institutions have not been able to afford it adequate bandwidth expansion, the newly introduced 1997 charge model (volume-based charging) will be difficult to meet from limited university technology budgets.

Uninet has a clear need for dramatically increased government funding and has approached the Department of Arts, Culture, Science and Technology through the FRD in the course of 1996. So far, no final decision has been made, but the signs appear to be encouraging. Higher-level discussions have taken place in late 1995 with Telkom SA, the national telecommunications provider, to enable Uninet to purchase bandwidth at lower costs, but with no success. This contrasts with other countries involved in leased line circuits for education such as Brazil. Currently, Uninet pays commercial rates.

Currently, technical network administration and the securing of funds for the present and future network are the main tasks of Uninet management. In light of its past and present involvement in connecting South African schools as well as the academic communities in various sub-Saharan African countries to the Internet, several of the correspondents questioned in this study indicated that Uninet might need to reconsider its vision statements to include the possibility to provide more network information and training services. Although some argue that hardware and network monitoring and maintenance could be out-sourced to industry by government tender, already a great deal of maintenance is out-sourced through an agreement with Dimension Data. By carefully reconsidering its policies, Uninet is likely to remain an effective way for South and southern African universities, polytechs and research centres to connect to each other and the Internet. Even though some institutions may from time to time consider purchasing more effective services, especially international bandwidth, elsewhere, the basic coherence of the network remains unthreatened as the national backbone connectivity between universities receives little criticism.

Increasing the number of schools networks and independent schools using Uninet as an Internet access infrastructure might not be advisable in the long term, unless the costs are carried by either the government or a national schools networking coordinating body which raises this funding in the private sector.

Introduction

Uninet is an academic and research network in South Africa. It sees itself as a "collaborative project among tertiary educational institutions, research councils" [http://www.frd.ac.za/uninet.html] with FRD both housing the project and acting as one of the collaborative bodies. FRD is a South African government foundation for the development of academic research, primarily in the 'hard' science, engineering and technology fields.

Uninet's main objective is "to provide a computer network that works to the standards of the Internet, for the use of every academic, researcher and student in South Africa" [http://www.frd.ac.za/uninet.html]. The network thus primarily focuses on building and maintaining an own South African network, with its secondary focus being the provision of
access to the Internet for South African scholars, assistance with bringing the academic communities of neighbouring countries on-line and encouraging the development of network and Internet literate human resources for the future.

From its historical origins in the late 1980s, the network has undergone rapid expansion in the first half of the 1990s and currently represents South Africa's largest internal TCP/IP network (excluding, perhaps, the government's network whose exact proportions are not known). Providing superb national connectivity (email interview F. Jacot Guillarmod (Rhodes University)), Uninet is characterised by its budget constraints and subsequent inability to expand its international bandwidth (its connection to the Internet in the United States) according to the demand of its members.

Having published its vision of a "Framework for Uninet as an Infrastructure for a National Research and Educational Network" in 1995, Uninet has to date not been able to secure adequate funding, either from the South African government or abroad, to finance its expansion into a network capable of handling the projected bandwidth-intensive multimedia needs of its members.

This document provides an analysis of the network, its infrastructure, management, budget, as well as problems and topical issues. It will also endeavour to make some recommendations and indicate some future scenarios for a South African educational network.

1. History of Uninet

1.1 Organisational

After early attempts at networking nationally and internationally, initially by Rhodes University in Grahamstown, Uninet was formally brought to life by the computer and network subcommittees of the Committee of University Principals (CUP) and the FRD. The networking efforts of the Universities, which became formal under the CUP in about 1985, floundered and were making little progress. At a meeting at RAU in 1987, the FRD, with the full blessing of the CUP subcommittee on computing, took the plunge of laying out the seed money that was necessary to get the networking efforts off the ground and appointed a manager (the late Vic Shaw). This seed money enabled the purchase of hardware and the running of the network for two years before any significant fees had to be raised from the participants.

The model of Uninet was drawn in part from the successful collaborative effort of NSFNET in the USA. The FRD management on numerous occasions has described the Uninet project as the most successful project ever run by the FRD. The FRD was asked to develop and manage the network and subsequently set up Uninet office at its headquarters in Pretoria in 1987.

The Uninet office continues to be financed in its entirety by the FRD. Membership to the network was open to all South and southern African universities, technikons (polytechs) and, eventually, primary and secondary schools. The main focus, however, remains today with tertiary education networking infrastructure and coordination.

The Uninet office is run by the Uninet manager in the FRD's employ, with the support of a technical assistant and an office administrator (secretary). With only three staff members, the human resources are enormously taxed and limited in meeting the demands of the network and membership.

The FRD maintained and maintains final decision making power over the administration of the network and has the full legal responsibility for areas such as fulfilling the agreements with Telkom for hiring circuits and honouring the period of agreements for services to/from the United States. The costs associated with this responsibility are significant. Uninet on-line documentation clearly states that "the FRD is responsible for the management of the network, and has appointed a Manager to handle this. Policy input is provided by a ten-member Uninet
1.2 Technical

Technically, the network was developed in a step-by-step process, according to the technical and financial capabilities of its member institutions and the FRD. In the mid-1980s, community network traffic was exchanged between Rhodes University (Grahamstown) and the University of Potchefstroom. The latter was part of a small academic/research network connecting Pretoria, the CSIR and Witswaterwand University, so it was via Potchefstroom that exchanges could take place with the CSIR. Soon began patchy, off-line (non-dedicated) traffic interchanges with the CSIR in Pretoria and the University of Cape Town.

The technologies used were not yet TCP/IP (Internet protocol) based, but indeed featured such diverse standards as proprietary IBM mainframe-to-mainframe communications, Fidonet, and UUCP (Unix-to-Unix-Copy; an off-line mail and net news transfer protocol).

Once the FRD had officially begun to take charge of coherent network development in 1987/88, the technology to provide live links (leased lines) between Uninet sites had begun to be available from Telkom SA (the telecommunications provider). Consequently, the rudiments of a backbone network were built by linking up strategic, so-called "hub" sites at the University of Cape Town (UCT), Rhodes University, the University of Natal (Durban), the University of the Witwatersrand in Johannesburg and the CSIR in Pretoria.

When demand for Internet mail and news transfers via UUCP began to out-strip the capacity of the dial-up links to the United States, it was decided to implement a live connection via a dedicated circuit from Telkom SA, connected to the AlterNet (UUNET Technologies Inc.) in Virginia.

This circuit historically and for many years remained connected into Uninet backbone network at Rhodes University. Its size increased rapidly, starting at 9600 bps analogue and growing to 256 kbps within 5 years.

It has since migrated once in terms of location: when in 1995 it became clear that Uninet demand on international bandwidth could be met more cheaply and possibly more effectively by purchasing international Internet bandwidth not directly from a US provider but indirectly from a local Internet service provider, Uninet board and management made the decision to receive its international bandwidth from SAIX, the then newly established Internet service provider company of Telkom SA.

After promises allegedly made by SAIX weren't kept and Uninet management threatened legal action because of breach of contract, the link of size 1 Mbps was connected to Uninet backbone at the University of the Witwatersrand in 1995.

1.3 Financial

From its inception in 1987, Uninet has always obtained its financial resources from various cost-bearers. It was and remains a not-for-profit network service provider whose task it is to establish and maintain a TCP/IP (Internet protocol) network starting at the protocol layer (consequently excluding physical infrastructure) and ending at the network services layer (which it leaves up to the member institutions to maintain themselves). The network is, in fact, a "loss-making network" (interview Mike Lawrie, Manager of Uninet). Obviously fees do not cover the costs. By law, the FRD sets the fees and has promised to take into account the comments of the Uninet Board.

The first tier of finance historically rests with the FRD. It is responsible for funding (and hosting) the Uninet office. This has included moderate equipment purchases over the years (such as various computers used in remote network maintenance), general office expenses as
well as the staff salaries of the two or three Uninet staff members, including Uninet manager. This cost has approximately ranged between R 200,000 and R 500,000 per annum over the course of the past few years.

The second tier of finance was an ongoing level of equipment donations by the FRD to Uninet, and subsequently to Uninet member institutions. This mostly concerns routing equipment: so-called "routers" are dedicated machines used to move data across wide area networks (WANs). After testing more than one supplier of Cisco routers (Cisco is historically one of two router manufacturers dominating the international market; the other is Wellfleet/Bay Networks), Uninet in 1995 settled on sourcing its routing equipment from Dimension Data (Pty) Ltd, a South African Cisco vendor.

The equipment purchases and other one-time costs (e.g. Telkom installation fee of R45,000/circuit for 6x2 Mbps circuits), adding up to approximately R1.8 million, are a high percentage of the R4.6 million operating budget of Uninet for 1996.

Routers were purchased and upgraded when necessary (the upgrade life-span of a router, according to Mike Lawrie, is currently approximately 3 years (interview)). Uninet office would purchase the equipment as needed, with FRD funds (augmented by a small component of annual membership or "joining fees" from Uninet member institutions) and transfer ownership of the routers to the institutions where they are housed. Consequently, UCT for instance owns the Cisco model 7206 router that constitutes its corner of the national Uninet backbone network.

The third tier of Uninet finance arises from membership fees and traffic volume based charges to the member institutions. Cost recovery has historically been the most contentious part of the network's finance model.

While charges for routing equipment and technical consulting services remain relatively constant (taking into account annual devaluation of equipment and increases in office costs), the price of national and international bandwidth for Uninet has in fact increased dramatically since its inception. While in 1988/89 64 kbps dedicated links seemed to fulfil most TCP/IP based applications' bandwidth demands perfectly adequately and could thus easily constitute Uninet backbone, by 1993/94 those links were inadequate in all Uninet locations other than very low-bandwidth intensive ones, such as smaller institutions that had recently joined.

A model based on bandwidth consumption consequently had to be devised. This was, for most years since Uninet's inception and up to the last three years (1998-1994) a model of "nominal" charges, indicating rather than calculating bandwidth consumption according to size of the institution. The universities of the Witwatersrand and Cape Town, for instance, would pay higher yearly charges than the universities of the North or the Western Cape (charge ranges that can be determined ranged from approximately R25,000 per year for smaller institutions to R 100,000 per year for larger ones).

However, since this charge model wasn't accurate enough to allow for fairness in charging to the various institutions and for network capacity expansion (national backbone and access circuits and international bandwidth), the charges were amended in 1996 to be made up as follows.

For 1996, A Uninet member institution would be charged:

- 1.) a fixed "membership fee" of R 2,500
- 2.) a charge for its own access circuit to Uninet backbone, made up of R 200 per kbps per year, a 64 kbps leased line into the backbone would thus cost R 12,800 per year.
- 3.) a usage-related fee, calculated by Uninet management office according to the percentage of the total international traffic a member institution had used in the preceding year. The basis for calculating this percentage were measurements made
across the routing equipment during the entire year.

Universities and other educational institutions were thus charged a "fixed rate" fee of between R 43,000 per year for very small member institutions to R 380,000 for larger ones in 1996 (Mike Lawrie, interview).

2. Present Situation

2.1 Membership

Membership of Uninet as at the end of 1996 (November) was as follows:

Backbone "hub" sites, connected to each other via 512 kbps leased lines:

- CSIR (Pretoria)
- University of the Witwatersrand (Wits)
- University of Cape Town (UCT)
- University of Natal (Durban) (UND)
- Rhodes University (Grahamstown) (RU)

Other Uninet sites, indicating Uninet hub connected to in parentheses:

- Border Technikon (RU)
- Port Elizabeth Technikon (RU)
- Transkei Technikon (RU)
- University of Fort Hare (RU)
- University of Port Elizabeth (RU)
- University of the Transkei (RU)
- Grahamstown Schools Network (RU) (not a "member")
- Port Elizabeth Schools Network (RU) (not a "member")
- University of the Free State (Wits)
- Technikon of the Free State (Wits)
- University of Lesotho (Wits)
- University of Swaziland (Wits)
- Rand Afrikaans University (Wits)
- Potchefstroom University (Wits)
- Mintek (Wits)
- University of Dar es Salaam, Tanzania (Wits)
- Vaal Triangle Technikon (Wits)
- Technikon SA (Wits)
- Technikon Witwatersrand (Wits)
- Gauteng Schools Network (Wits) (not a "member")
- University of the Western Cape (UCT)
- South African Library (UCT)
- SA Astronomical Observatory (UCT)
- SA Museum (UCT)
- Stellenbosch University (UCT)
- Medical Research Council (UCT)
- Cape Technikon (UCT)
- Peninsula Technikon (UCT)
- National Botanical Institute (UCT)
- Institute for Maritime Technology (UCT)
- National Accelerator Centre (UCT)
- Sea Fisheries Research Institute (UCT)
- Western Cape Schools Network (UCT) (not a "member")
- Vista University (CSIR)
- Human Sciences Research Council (CSIR)
Foundation for Research Development (CSIR)
SADC Headquarters, Botswana (CSIR)
Technikon of the Northern Transvaal (CSIR)
University of the Western Transvaal (CSIR)
University of South Africa (Unisa) (CSIR)
University of Venda (CSIR)
Hartebeesthoek Radio Astronomical Observatory (CSIR)
Technikon Pretoria (CSIR)
University of Pretoria (CSIR)
University of the North (CSIR)
Sabinet (CSIR)
Medunsa (CSIR)
Pretoria Schools Network (Pretnet) (CSIR) (not a "member")
University of Eduardo Motlane, Mozambique (UND)
CCWR (UND)
University of Zululand (UND)
University of Durban Westville (UND)
Mangosuthu Technikon (UND)
Natal Technikon (UND)
Natal Schools Network (UND) (not a "member")

(There may be some additional, minor sites that could not be identified adequately at the time of writing. Those where "not a member" is indicated indicates that connections are on a best-effort basis. The other connections are covered by formal legal agreements)

Each of these sites is considered a full Uninet member, except for the various schools networks whose participation is currently, pending further discussions between Uninet management and Uninet Board, free. There may also be legal implications preventing some of the member institutions in other countries from becoming full members with the same charge structure as the South African members. Traffic is in most cases minimal, though, since the connections are almost all lower-quality international access circuits. The main cost in connections to the southern African region is that of the access circuits.

The Uninet manager is tasked with covering at least the traffic component of the Uninet fee for school traffic. The approach is to do this via the school networking groups, not via the individual schools. Networks in other countries are treated as independent networks - Uninet cannot and does not interfere with their policies. The tariffs to these countries are essentially similar to what a South African Uninet participant would pay, but the access circuit is replaced by the full cost of the circuit from the African country to Uninet.

2.2 Organisational structure

Uninet is managed by the FRD, which is solely responsible for the management of the network. However, "policy input is provided by a ten-member Uninet board" (http://www.frd.ac.za/uninet.html). The board consists of five members elected by Uninet member sites (directors of university computer centres, etc.), three members appointed by the President of the FRD, a Vice-President of the FRD and Uninet manager. The chairperson of Uninet Board is appointed by the president of the FRD.

"Elections and appointments usually take place towards the middle of each year. Terms of office of the elected and appointed members are normally for three years" (http://www.frd.ac.za/uninet.html). The board usually meets twice a year and is responsible in large part for determining the membership and operational fees paid by each member of Uninet.

Uninet Board currently consists of
2.3 Management

The current Uninet office is managed by Mike Lawrie. His background is IT management in the university field. As Computer Manager at Rhodes University from 1971-1994, he led the team at the University in the networking efforts that connected South African researchers to the Internet in 1989, he set up the first of South Africa's wide area Internet connections, and found the way to solve the political and technical problems associated with connecting South Africa to the Internet in the apartheid era. Mostly during this same era, he established e-mail links to some ten African countries. He is assisted by Manoli Piperakis as Technical Assistant and Karen Currin as secretary. The offices are situated at the FRD headquarters in Pretoria, in close proximity to the CSIR's conference centre and thus close to one of Uninet hub sites (CSIR).

Lawrie describes himself as a "technocrat" (interview) and indicates that his main tasks are managing the running, maintenance and expansion of Uninet network on a day-to-day basis as well as securing the finances for its current and future needs. Promoting connectivity among new member institutions of the tertiary level or primary and secondary schools is something he would like to do but scarce resources do not permit this on an active basis.

Of necessity, it is Uninet management policy to become active only once a new member has made the informed decision - based on information Uninet office supplies readily - that it wishes to join. Then, technical and financial contacts are established and Uninet office initiates ordering of the necessary equipment, Telkom SA lines, etc.

Lawrie is also careful to point out that other than in an advisory function, Uninet offices cannot get involved in the management of higher-level network, computing or information provision functions. These functions continue to be put in place and maintained by the member institutions themselves. Services referred to are Domain Name Service (DNS), Internet electronic mail, World Wide Web servers, etc.

Historically, this has posed some problems, especially at the historically disadvantaged universities where the high-level skills needed to actively maintain such services have not been forthcoming inside the university community, due to budget or other constraints. Peter van Heusden, an IT and network administrator at the University of the Western Cape (UWC), points out that "there is quite a high concentration of services in a fairly small number of 'core' sites in Uninet. ... Expertise is also quite concentrated - knowledge about DNS configuration, running news servers, configuring Cisco's, etc, is quite rare in SA in general, and only a handful of people in Uninet possess this knowledge - mostly at the core sites" (email interview).

Lawrie's response is that due to the limited technical and human resource capacity of Uninet office, it is in fact unable to help with installations and maintenance at the member institutions beyond giving advice where possible. Uninet office treats all member institutions alike, both in terms of charges and expertise (interview). Other Uninet networking technicians and system administrators point out, however, that Uninet office is almost always helpful when approached and that Mike Lawrie in particular offers aid beyond the call of duty (email...
There are also concrete examples of Lawrie's assistance. He arranged with TIS that they take staff from Uninet sites onto their TCP/IP courses at a 50% discount, given that they have place on those courses. He then arranged with the program managers with the FRD that support the upliftment of HBUUniversities and HBTeknikons to identify and to fund IT staff from those institutions to go on those courses. The full costs were covered and the staff from the University of Venda, the University of Zululand and the UniWest went on those courses. From the UWC there was no one interested in attending.

Also, Lawrie was instrumental in arranging for Tim Bouwer of Rhodes to spend a week at UniWest, sorting out technical problems with the TCP/IP internal routing and giving some courses. The IT staff at UniWest, once encouraged to take up the offer to spend a week at Rhodes getting on the job experience, indicated the experience as having had a significant impact.

2.4 Technical description

Technically, Uninet currently consists of the same six-segment backbone structure outlined above, where the CSIR, the University of Natal (Durban), Rhodes University, UCT and the University of the Witwatersrand are connected together via 512 kbps permanent leased circuits from Telkom SA. These six segment circuits are soon to be upgraded to 2048 kbps (January/February 1997), as Telkom capacity becomes available (November 1996 network diagram attached in appendix).

This backbone network is about to be connected to the Internet at current a speed of 1280 kbps (1.2 Mbps) to The Internet Solution (TIS), a commercial provider situated in the Gauteng region. The network migrated across from SAIX at the beginning of 1997 due to a lower price being offered by TIS. Mike Lawrie also hopes that the level of network monitoring and response times in the case of downtimes might be better at TIS who constitute a major competitor to SAIX.

The various member institutions connect into this backbone at one of the hub sites (usually the one geographically closest to their location), typically using 64 kbps or 128 kbps Telkom SA circuits, as necessary. Some sites connect at higher speeds because from a network load point of view they constitute a site with major traffic (e.g. Stellenbosch University's connection to UCT).

Uninet has a standing maintenance agreement with Dimension Data, a Cisco routing equipment hardware vendor. This means that Dimension Data technicians may be called out to perform major maintenance work on the routers, as necessary (after hours service is available at additional costs). Other router and software failures are addressed by Uninet office when possible, during office hours, Mondays to Fridays. Some of the network technicians interviewed described this level of maintenance as not comprehensive enough, especially as network downtimes just upstream (i.e. at one of the hub sites) can affect downstream users (at a connected institution) negatively on weekends or public holidays without there being adequate recourse (email interviews).

To address this situation, however, Uninet would either have to expand its presence to all of the hub sites or the member institutions would have to agree to making their own technicians available on a 24x7 basis to perform maintenance on Uninet equipment. As it stands, Uninet has only one technical assistant no staff.

In the current budgetary and management discussion around the present and future Uninet situation, and especially in light of the key component of the network - its provision of access to the Internet - being so problematised, this debate has taken a lower priority at the moment.
It is important to note that Uninet has experienced strong frustration with the delays caused by Telkom in general and, according to its staff, promises not kept (e.g. installation of circuits, including at HBlInstitutions which have taken more than a year). This has had a major impact on the service facilities that Uninet can provide.

2.5 Budget and budget projections

Uninet budget and costing structure was substantially revised for its 1997 operations. The basic nature of a "loss making network" (Lawrie) remains; however, due to the growth demands made on its administration, certain changes have been introduced with effect 1 January 1997.

The FRD continues to solely fund the operation of Uninet office in Pretoria. The running costs for this are estimated at approximately R 500,000 for 1997. This includes staff salaries, office equipment and all sundries. The FRD, according to Mike Lawrie, also remains amenable to the further grant of routing equipment should new sites wish to come online using Uninet. The purpose would be for network-wide facilities, not at the time of connecting an individual site. The last grant was for R1.6 million toward the end of 1996, which covers the costs of a significant upgrade to the backbone routers and the capital costs of installing 2 Mbps Telkom circuits.

To cover the operating costs of the network as well as its on-going expansion, the 1996 three-tier charge model was amended to become at once fairer and more flexible. It is now a four-tier charge model and operates as follows:

1.) The first tier is a basic membership fee. It amounts to R 11,500 per year regardless of the size or financial capability of the member institution.
2.) The second tier remains the same as in the 1996 charge model, viz. an access circuit charge or R 200 per kbps per year. A 64 kbps access circuit to Uninet backbone amounts to R 12,800 per year.
3.) Local traffic (traffic is defined as the measurement of networked data exchange taking place) transported across Uninet backbone is charged at R 0,60 per Megabyte to the originating or requesting member institution.
4.) Incoming international traffic is charged at R 2,50 per Megabyte to the requesting member institution. (There is currently no charge on outgoing international traffic.)

This new charge model introduces accurate charging and billing for actual network resources used, according to Mike Lawrie (interview). As it is "relatively difficult to put an exact price on bandwidth used" (Lawrie interview), Uninet management and board might have set the price per Megabyte transferred slightly higher than absolutely necessary. This, however, represents in part Uninet administration's medium term strategy.

As the international bandwidth constitutes the current main constraint on network performance and maintenance, Uninet office hopes to be able to purchase more bandwidth as the slightly higher charges to member institutions permit it to spend the surplus. Mike Lawrie predicts that he will be able to purchase more 64 kbps channels of international bandwidth from The Internet Solution as 1997 progresses and the bandwidth becomes necessary. He has, in fact, secured an agreement with TIS to that effect and the technical capacity for incremental bandwidth upgrades is being put in place during January 1997 (interview Mike Lawrie; interview David Frankel (TIS)).

However, Mike Lawrie further predicts that the planned incremental bandwidth increases will in the longer term not be able to cover the increasing demands of the academic and research institutions. Covering this 'bandwidth gap' will in fact require substantial additional funding, which Lawrie eventually hopes to secure "at the highest ministerial level" (interview). The Department of Arts, Culture, Science and Technology (DACST) has been approached on various occasions and Uninet management hopes that funding will be forthcoming in the
future. This topic will be discussed further below.

The process as described above will deal with the increasing demand. The problem that will occur is that the sites will not be able to continue to pay for the traffic that is needed because they are running on heavily constrained budgets. As Uninet provides more bandwidth such that it is ahead of the demand curve, more traffic will flow as a result. As more traffic flows, so the sites that generated traffic will pay more. As they pay more, so more capacity will be bought by Uninet, and so the cycle will continue until the sites apply controls on their demand. Given the nature of the demand for access to the Internet, the sites will end up paying a large percentage of their budgets on Internet services, but will be getting a good service unlike in previous years (Lawrie).

2.6 School connectivity

Although adding any additional traffic to the existing infrastructure, especially from schools that connect 'live' to the Internet via Uninet, has to be seen as an additional strain on network performance and consequently on the Uninet budget, Uninet has a policy that 'cautiously' encourages schools to connect to the network. At this point, the strain on staff resources at Uninet and the original objectives of Uninet do not allow it to commit to schools in as strong a way as they might desire. At the same time, the current staff have undertake some concrete measures such as encouraging the school networking groups, developing the connectivity model, and attracting a donation from Cisco Systems SA of R1 million for routers to connect schools to the Internet via Uninet.

A school is defined as "an educational institution that provides education up to a secondary level to full-time pupils of normal school-going age" [http://www.frd.ac.za/uninet/docs/schoolscond.html]. Uninet encourages such institutions to develop, largely in own initiatives and in conjunction not with Uninet management but with an individual Uninet member (a university or technikon), a cheap, off-line or lower-grade on-line connection model that provides either full but slow or limited Internet services.

The main feature of this connection model is that Uninet subsidises such connectivity by currently not charging a Uninet connection fee to the school. Uninet documentation states, however, that in all cases the school carries the cost of the access circuit or dial-up connection necessary to collect and transmit electronic mail [http://www.frd.ac.za/uninet/docs/schoolscond.html].

Currently, there are three different types of connections maintained by schools to Uninet: 1) UUCP mail transfer only, allowing pupils and teachers an own mailbox but no 'live' connectivity, 2) lower-grade, analogue leased line circuits up to 28.8 kbps, allowing moderately fast 'live' access to the Internet, and 3) higher-grade, digital leased line circuits at 64 kbps, allowing for fast, reliable full network access.

According to Uninet documentation, for types 1) and 2), Uninet does not charge the school an additional network or traffic fee. For option 3), as outlined in Uninet documentation [http://www.frd.ac.za/uninet/docs/schoolscond.html], the school will eventually be to be charged like any other full Uninet member institution, i.e. at the same rates.

Currently, most schools connect through local school networking initiatives, run largely by volunteers. This means that technically (and from a network routing point of view), the school network connects to Uninet backbone at one of the hub or full Uninet member sites, and the individual schools, in turn, connect to the school network (interview Lawrie; interview Stephen Marquard (Western Cape Schools Network)). With the introduction of the new Uninet charge model, the issue of charging the respective schools network remains to be resolved. Mike Lawrie as well as the various paying Uninet member sites indicate that the school networks might have to be charged for national and international traffic like any other Uninet member institution (interview Lawrie; email interviews network administrators).
In terms of technical and policy support, Uninet documentation states clearly that the management office is unable to assist in school connectivity initiatives beyond providing a first place of contact and providing some rudimentary information to the enquiring school. The reason given is that the "Uninet office is kept pretty busy in dealing with the paying users of Uninet, and is not staffed to handle the connections of the more than 25,000 schools that are in the country" [http://www.frd.ac.za/uninet/docs/schoolscond.html].

While perhaps technically inevitable, the lack of encouragement for schools that the documentation betrays leaves much to be desired: "If the school wishes to connect, there will be lots of help and encouragement. If it doesn't, well, that's the choice of the school" [http://www.frd.ac.za/uninet/docs/schoolscond.htm].

The experience with Uninet-connected schools networking varies throughout the various initiatives that are underway in the country. The questioned school networking coordinators, however, almost unanimously stated that the help and encouragement received from both Uninet office and the respective member institutions (with the initial exception of the University of the Witwatersrand) had been tremendous and positive. It may be assumed that these technology 'early adopters' had competent and experienced personnel at their disposal when setting up an initial connection, and such competence was rewarded by Uninet's 'hands-off' policy on schools networking.

According to Stephen Marquard, network administrator at the Western Cape Schools Network (WCSN), there are currently 249 South African schools connected to the Internet by means of one of the above connection models (http://www.wcape.school.za/za/conrvw96.htm). This constitutes approximately 1% of the roughly 25,000 South African schools. Of these schools, a small number of the financially better situated private schools have private, 64 kbps leased line circuits through commercial ISPs.

2.7 Regional/international connectivity

Regionally, Uninet currently connects five foreign institutions via leased lines and several using dial-up UUCP connections.

The leased line connections are to the SADC (Southern African Development Community) headquarters in Gaborone, Botswana; to the Lesotho National University; the University of Eduardo Motlane in Mozambique; the University of Dar es Salaam in Tanzania; and to the University of Swaziland.

UUCP dial-up connections vary in number from time to time, but there are always around 10 of them connected to Uninet, mostly to Rhodes University in Grahamstown. Connectivity runs as far afield as the Association for African University offices in Accra, Ghana. Mike Lawrie expressed Uninet’s pride in having been involved in bringing these remote international sites online (interview). This view is borne out by correspondents at Rhodes University who, together with many UUCP sites, made this connectivity work.
3. Problem areas

3.1 Budget constraints on expansion and delivery of service levels

Uninet's budgetary constraints, as outlined above, are currently as much under discussion as any of its technical aspects in the Uninet community. As the IT and networking fields are only beginning to make a substantial, demonstrable impact on education (through online information gathering, distance education, exchanges with scholars and peers in other geographic locations, etc.), South African university administrations are difficult to persuade that greater expenditures in this field are justified. At the same time, the bandwidth and service level demands of up-to-date applications (World Wide Web, video and audio conferencing, etc.) demand that such high-quality bandwidth be readily available when necessary.

With the introduction of the new Uninet pricing model, the purchasing of small, incremental amounts of additional bandwidth will become possible in the course of 1997. However, some traffic figures for 1996 suggest that when charged by Megabyte of traffic, some of the larger Uninet member institutions, such as UCT, Stellenbosch University and the University of Natal (Durban) will pay yearly Uninet charges that are much higher than in previous years. Yet these charges represent actual usage (and, therefore, load on the network) much more accurately than in previous years (interview Lawrie).

Comparative figures of bandwidth usage from 1996 are as follows:

University of Cape Town (UCT)
- international traffic - 167,000 MB
- national traffic - 202,000 MB

University of the Western Cape (UWC)
- international traffic - 12,000 MB
- national traffic - 13,000 MB
Uninet - The South African academic and research network

Cape Technikon

- international traffic - 14,000 MB
- national traffic - 142,000 MB

The Western Cape Schools Network, according to Lawrie, routes about as much traffic across the network as the University of the Western Cape.

Uninet is the only network in the country that publishes usage figures, and indeed traffic flow figures (http://www.frd.ac.za/uninet/mthuse.html).

For the larger Uninet member institutions, it may in fact be possible to purchase either only international bandwidth or complete Internet connectivity from a commercial Internet service provider (ISP), as the larger volumes may allow them to negotiate discount pricing. Rhodes University already purchases its international bandwidth from The Internet Solution while it continues to route its local traffic (to Uninet member institutions) across Uninet backbone. This will be elaborated below.

For smaller Uninet member institutions as well as large, but historically disadvantaged and underfunded universities and polytechs, 'leaving' Uninet in favour of commercial connectivity is not an option for two reasons. A university with a 64 kbps or 128 kbps bandwidth requirement cannot negotiate discount bandwidth with commercial ISPs as these would have to treat such an institution the same as any corporate client (with a potentially higher maintenance requirement). Secondly, the degree of support received from Uninet community and Uninet office cannot be over-estimated when determining the viability of a 'smaller' site coming and remaining online. This is something that few commercial ISPs, used to dealing with corporations that can afford own IT expertise for network maintenance, would take on as a responsibility.

Some see a deeper problem when trying to use commercial ISPs. The nature of research and academic traffic is completely different to that of commercial traffic and the two do not easily mix. A commercial site will have busy traffic in the day and little in the evening. For a research and education institution, the traffic can flow around the clock. The commercial ISPs are drive by the profit motive, the demand for bandwidth by the academic community is not.

3.2 Interaction with private sector providers / members leaving

There has been considerable discussion around certain Uninet member institutions purchasing their international bandwidth from commercial ISPs. Although this might threaten the cohesion of the network eventually, Mike Lawrie says he has always encouraged Uninet members that came forward with the 'threat' of leaving. "If they can find the bandwidth cheaper elsewhere, then it's perfectly acceptable for them to leave" (interview Lawrie).

Lawrie makes the point that if a commercial service is undercutting a profit-losing service like Uninet, then that profit-making service is subsidising that Uninet site. Lawrie maintains this has to be the case. Uninet gets not only grants from the FRD for the purchase of routers and installation of circuits, etc., but also educational discounts for routers from Cisco, unlike a commercial ISP. Both Uninet and the ISP pay the same for Telkom services. If the commercial ISP offers a lower prices than Uninet, then it makes sense that some of the profits are being lost in favour of gaining the client. Under this scenario, Lawrie warns only that one should be careful of motives and sign short-term agreements.

Currently, only Rhodes University obtains its international Internet bandwidth from a commercial provider. This is seen as "substitution", as RU remains connected to Uninet for all its national bandwidth.
Dave Wilson, Director of the Rhodes University computer centre, describes the need for Uninet cohesion as follows: "I think complete membership is required. For example, at one stage Rhodes decided to withdraw. At the time we were not only the international hub site, but also the hub site for the Eastern Cape. If we had withdrawn (we didn't, but now supplement our services with another ISP), it would have had serious implications for this region. Logistically, moving everyone onto an alternative hub would have been a nightmare, and I also do not believe there is any other site in this region with the technical skills to run such a hub" (email interview Wilson).

None of the universities questioned thought that leaving Uninet altogether and purchasing all their Internet connectivity through a commercial provider was the answer to the service or bandwidth problems that they are experiencing.

Rhodes University’s "major reasons for leaving were that we did not feel Uninet board, and the management, were taking our concerns seriously enough. These concerns related to the following: a) lack of agreed service levels, b) lack of adequate network traffic management, c) an attitude of network bandwidth growth at (almost) any cost, regardless of the impact on subscribers (and) d) lack of proper representation on Uninet board" (email interview Dave Wilson). At the same time, FRD did attempt to respond to these concerns from its perspective, including a high level personal visit from the Foundation.

When asked whether he feels there would be a need for a Uninet office should Uninet backbone cease to exist in a scenario where all current Uninet member institutions in fact decided to purchase their connectivity elsewhere, Wilson responds that perhaps the backbone should be maintained by a commercial ISP instead (email interview). The Uninet office, due to budget and staff limitations, can in fact not deliver the 24x7 network monitoring levels that commercial operations maintain routinely.

At the University of the Western Cape (UWC), "the South African National Bio-informatics Institute (SANBI), (...) switched over to IAfrica because of bandwidth and reliability issues. SANBI is involved in things like genetic databases, which results in large amounts of data being passed around the world - gigabytes/week apparently. They can’t afford to have much downtime, so they now have a 64k link to IAfrica" (email interview Peter van Heusden (UWC)).

The effect of this has been that inside UWC, which in most part remains connected to the Internet via Uninet, there is now a pocket of ‘topical’ connectivity that van Heusden thinks is more reliable for the purposes that it is intended. Once again, network reliability and bandwidth (in this case, throughput speeds for time-critical work) appear to be the main issues. The level of trust placed in commercial operations such as UUNet Internet Africa, a subsidiary of the US-based UUNet Technologies Inc., is higher than the trust placed in Uninet.

Apart from the various Uninet member institutions discussing the advantages and disadvantages of leaving the network in favour of self-purchased connectivity, there are various independent initiatives underway. In the Western Cape, the universities and polytechs are discussing the implementation of a high-speed inter-institution network aimed at supporting bandwidth-intensive applications such as video conferencing. Initiated by the Western Cape Tertiary Institutions Trust, this bandwidth could be used towards a potential finite element analysis research project (email interview van Heusden). CALICO, the Cape Library Cooperative, also maintains some high-speed links between Cape tertiary institutions for multi-media transfers of data. In both cases, there doesn’t appear to be any substantial involvement of commercial ISPs or other network providers.

As regards the interest that networking companies in the private sector take in Uninet and its member institutions, it appears as though this is limited to treating the education network as a customer like any other. As Mike Lawrie points out, not even Telkom is prepared, even after discussions at the highest level, to give educational rebates on the large number of access circuits rented (interview Lawrie). It is unclear whether Rhodes University was able to secure
lower cost bandwidth through TIS. However, as F. Jacot Guillarmod, network administrator at RU, points out, direct cost is not everything when it comes to networking: there is also the relation between service levels and own involvement required in maintaining the network (email interview Guillarmod).

Uninet has secured some sympathy from the Internet Service Providers Association, a grouping of ISPs formed to take Telkom’s SAIX service to the Competition Board. They will be funding a 2 Mbps peering link in the near future.

3.3 Management problems

Management costs for Uninet are currently borne by the FRD. The three posts are clearly inadequate for the maintenance and further development of the sizeable network and there has been resistance to increasing this staff component to more realistically meet membership and network demands. Historically, Uninet member sites have contributed their staff expertise in a collaborative effort to manage routing and other equipment problems. Hardware management, especially in cases where actual repairs or replacements are required, is aided by Uninet’s standing arrangement with Dimension Data.

For the most part, the contentions that Uninet member institutions have voiced about Uninet management are related to the fact that Uninet office can’t provide 24x7 networking monitoring and that often, problems can only be addressed either the next morning or after a weekend or public holiday (various interviews).

Further to this, some members and one former member have expressed their reservation about the Uninet manager who sees himself as a 'technocrat' and consequently displays little concern for those universities, polytechs and schools that do not have the requisite expertise to join the network by themselves. These correspondents felt that it should be Uninet office’s concern to bring online those institutions from historically disadvantaged communities which, by definition, fall under Uninet’s umbrella.

Uninet office responds to this by pointing out that traditionally, such institutions should get as much help from other, already connected Uninet members as from Uninet office (interview Lawrie). This help might not be forthcoming as the knowledge gap increases between historically advantaged and disadvantaged institutions due to a lack of funding in both camps. One correspondent pointed out that it is difficult to lend help to a school wishing to connect to the network when one’s own IT department is understaffed and under skilled.

Another correspondent alleged that Uninet management had made the "political decision" not to raise adequate funding from international donor organisations due to a hidden agenda. However, this allegation was not backed up by any evidence, and Mike Lawrie is currently actively seeking funding to purchase more bandwidth. What might need revisiting from a management point of view, though, is the question whether Uninet office has defined its task adequately in merely being responsible for the maintenance and expansion of the technical aspects of the network. This is clearly a point for discussion by the FRD Council.

Some correspondents felt that as defined, the tasks Uninet office had set itself were fulfilled adequately, with the major contention being the lack of permanent network monitoring. However, since Uninet board, the FRD and Uninet management are solely responsible for setting these tasks, it was felt that perhaps the scope of Uninet project (provided there would be adequate funding) should be expanded to include network information services, training coordination measures and active participation in and initiation of connecting new members.

3.4 Cooperation with NGO networks and OpeNET

There is currently no cooperation between SANGONeT (the South African NGO Network - a not-for-profit Internet service provider), OpeNET, the GNU’s newly formed network, and...
Uninet. At the same time, it should be pointed out that SANGONet is not a provider of network services in the sense of hiring circuits, installing routers and the like.

The government’s OpeNET, according to one of its network administrators, is a TCP/IP network aimed at providing government ministries, departments and institutions with Internet connectivity (email interview Sean White). It also has a small Internet publishing and information component which appears to be in its infancy at the moment (January 1997). White is in fact not able to give exact information on the number of government bodies connected at the moment and also cannot say exactly who they are. The primary focus is in the provision of Internet services to government, and there is a significant need to provide adequate network security.

SANGONet, started in 1992, is a not-for-profit network service provider to the NGO community. It sees its role in supplying affordable Internet access, providing training, and in online publishing. There are several points of presence country-wide. This network is largely aimed at the dial-up user, targeting small and medium organisations with a networking need. SANGONet was connected to Uninet in 1994 as it was not for profit and had a significant training component. Uninet enabled their connection with some “bending of the rules”.

In April 1996 SANGONet left Uninet after the service levels and the levels of "responsiveness" (interview Anrette Esterhuysen (Director)) on the side of Uninet management weren’t forthcoming. It has since joined UUNet Internet Africa and maintains a leased line circuit through that company.

Neither the OpeNET nor SANGONet see much scope for increased collaboration with Uninet. By itself, Uninet represents an access infrastructure only and has no added value (i.e. in the field of content provision). Correspondents from both SANGONet and OpeNET see Uninet’s country-wide penetration as a benefit and acknowledge its backbone network as potentially a major carrier for a South African Internet infrastructure, but register their reservations about this on two counts: 1) Uninet capacity problems; and 2) the fact that the ‘customer base’ (in other words, the user groups) are quite divergent. The needs of a hospital and the needs of a school are not alike.

F. Jacot Guillarmod from Rhodes University, for example, was quite excited at the suggestion of exploring points of convergence between the government network and Uninet. RU in fact are running a pilot project at the moment. “We’ve just gone through an exercise of linking our library to some or other Govnet database. I’ve spoken to some of the guys there – Sean White - and have been pleasantly surprised. It’s different to the old bureaucracy” (interview Guillarmod).

Guillarmod is "very fond of pointing out that there are 64 kb links in places like Fort Beaufort (our local version of Pofadder) or Rouxville that probably have one or two broken PC’s stuck on the end and gathering dust. You could do a heck of a lot with 64 kb at the schools/libraries in those parts of the world" (ibid.).

In summary, there appears to be some scope in looking at local initiatives to inter-connect the government and research networks, as illustrated by the experiment at Rhodes University. However, to utilise OpeNET’s circuits more effectively in schools networking and other rural or remote area projects would require an additioned planning, forecasting and security implementation capacity that the government’s relatively small networking department currently doesn’t appear to have while it implements the requirements of government institutions. Local initiatives with a component of ‘personal networking’ will most likely prevail in this area for a while to come.

3.5 The impact of increased school connectivity on Uninet

Currently, no more than 1% of all South African schools are connected to the Internet, with
about 95% of the schools connected linking to Uninet in one way or another. With various projects active on this front, it can safely be assumed that this percentage will increase. As all of the regional schools networks are currently connected through Uninet, it can further be assumed that Uninet’s traffic, both on its national backbone and across its international link, will increase dramatically over the next two years.

Uninet office, having already indicated that it might not be able to sustain free schools connectivity for much longer and might have to start charging the schools networks as regular Uninet member institutions, has provided some capacity and financial projections for such a scenario.

The costs vary according to the speed and quality of the envisaged connections, but ballpark figures, in 1996 Rand, indicate that a school connected at 256 kbps would have to pay an initial connection cost of R 20,728 and a 1997 annual fee of R 30,750. Similar equations are given for schools connecting via 64 kbps lines, analogue leased lines and dial-up UUCP connections. These are not Uninet fees but the costs of the equipment and the access circuits.

At the projected number of schools, this could run into millions of Rand. The calculated figures also do not indicate the additional bandwidth requirements on both the national backbone and the international access circuit. However, Mike Lawrie indicated that usage of the Western Cape Schools Network is roughly equal to that of the Cape Technikon. At the same charge level, this would imply that a school would not only be liable for the connection costs (as previously), but in fact also for their share of the national and international traffic generated. At a 64 kbps connection and active usage, this could well imply an additional annual cost of R 50,000 or more. The big cost of networking comes circuit costs, Lawries points out.

Consequently, given the current constraints on Uninet network, it is impossible to continue planning network resources without taking the traffic generated by currently online and future schools into account. Mike Lawrie estimates the potential number of Uninet Internet users at universities and other tertiary educational institutions exceeds 500,000 currently. Adding to that the students at 25,000 schools nation-wide is an endeavour that would require major government funding.

However, since in January 1997 the school networks have given themselves a national coordinating committee, predictions and actions might soon become more accurate and realistic. In the Western Cape, for instance, the provincial education department is already beginning to take an active interest in the achievements of the Western Cape Schools network, according to Stephen Marquard (interview).

Several correspondents believe Uninet needs to carefully examine its policies on this matter. Having been initiated as an academic and research (i.e. tertiary education) network, it might well find that it is not its responsibility to continue bringing schools online, especially if there is going to be a national coordinating body for schools networking. This remains in the air, however, until and unless someone hires circuits, installs routers and staffs the necessary facility. According to staff, when and if this happens, Uninet will be fully cooperative.

3.6 Support and funding from national and provincial education departments

There is currently no support of Uninet from the national or provincial education authorities. Uninet discusses its funding and future through the FRD’s channels to the Department of Arts, Culture, Science and Technology (DACST), the body which the FRD itself reports to.

Mike Lawrie feels that the Department should take an active stance eventually in allocating and providing substantial ongoing funding for networking schools, whether it is via Uninet or not (interview). At the same time, the Uninet infrastructure is a candidate for the networking component. This is in keeping with Uninet’s 1995 vision document which states that Uninet aims to discuss with the Minister of Arts, Culture, Science and Technology the "necessity of a
national education and research network" [http://www.frd.ac.za/uninet/docs/vision.html]. At regular meetings between DACST and the FRD management, Uninet issue has been discussed and an understanding has apparently been reached that there is a need for funding.

An official request from the FRD for Uninet to be represented more substantially in the DACST’s budget was made in May 1996 and reinforced in October 1996 (interview Lawrie). This was added as a separate item to the normal budget submission process of the FRD. There have been several follow-ups since and the signs, according to Lawrie, look "encouraging" (interview).

On the provincial level, the education departments are only peripherally interested in Uninet’s operation and in educational networking in general. Their interest focuses primarily on primary and secondary education. Stephen Marquard points out, for instance, that the Western Cape Education Department (WCED) is now beginning to take an active interest in networking and telecommunications in schools under its jurisdiction. The Department has committed R 245,000 to the implementation of Internet infrastructure between teachers’ centre in Cape Town, Parow, Worcester and Oudshoom and remote dial-up points of presence. "The WCED will take over basic (introductory) and subject-related/educational Internet training activities for Western Cape schools" [http://www.wcape.school.za/za/conrvw96.htm]. Budget pressures on the Department do not permit it to investigate provincial involvement with university or technikon networking.

In the Free State, a project funded by the Free State Education Department in 1992-1994 has been cancelled and is no longer operational. According to Marquard’s annual schools connectivity review, four schools in the area are currently discussing the formation of a new schools network [http://www.wcape.school.za/za/conrvw96.htm].

4. Recommendations/Concluding remarks

Among Uninet’s major strengths is its dedication to maintaining the highest-quality network available with the limited funding it has received from both government/FRD and its member institutions. National connectivity does not represent a problem for Uninet: its backbone reaches into strategic areas of the country and is within reasonable geographic proximity of its 'market', the member institutions. Further to this, its national bandwidth is adequate or "excellent" as one network administrator describes it (email interview Guillarmod) and its technical service levels in accordance with the limited staff and funding available.

Uninet’s weaknesses can be summarised as follows:

**International bandwidth:** It remains to be seen whether the current 1280 kbps link to the Internet via The Internet Solution will make an improvement when the universities return for the first semester in 1997. If Uninet sites have decided for budgetary reasons to apply internal constraints on their users, then the capacity could prove to be more than adequate. Even with Uninet management’s current plans to incrementally increase the bandwidth as slight surplus funds become available from the recently introduced exact charge model, international bandwidth is going to remain a major set-back for the network’s expansion of services. Projected figures show that for optimal network growth, bandwidth in excess of four times the current link speed should be available at year’s end, which under the current funding model is improbable.

Educationally, it is not advisable to force Uninet member institutions to self-impose bandwidth limitations on their students and staff, as Uninet management currently does with its 1997 charge model. The only systemic restraint on ever-increasing bandwidth demands is in fact bad network performance, as one observer points out (http://www.uct.ac.za/depts/its/dit/quovadis.htm). Bandwidth-intensive Internet applications have no other built-in mechanism to restrict the user from consuming more and more
However great the need for network and Internet literate human resources may be in South Africa, the education authorities and institutions are already hard-pressed to maintain the levels of funding currently invested in Uninet and their respective IT infrastructures. The only feasible way forward for Uninet to continue its educationally beneficial technical expansion would be through major and continuing government funding. Uninet management is undertaking steps to secure such funding and the signs are tentatively positive that it will be obtained.

When securing increased government funding, emphasis should also be placed on enabling, if necessary at the highest ministerial level, Uninet to obtain more cost-effective bandwidth from Telkom SA. Currently, Uninet is being charged at normal commercial rates. Uninet management and a high level delegation from the FRD has on previous occasions attempted to discuss this with Telkom, including at the Managing Director level, but this has met with no success. Some intervention is needed here.

**Limited task definition:** Uninet's tasks are most likely too narrowly defined at the moment. Many of the correspondents point out that the purely technical nature of Uninet management's task description leaves much to be desired as far as the further development of South and southern African educational networking is concerned. Various sources suggested that Uninet's tasks be migrated away from being responsible for network maintenance and expansion (i.e. infrastructure), which could feasibly and with government funding be put out to tender among the commercial Internet service provider and networking community, and towards the fields of network information provision, promotion of networking and Internet use in the educational and research communities, network coordination, training coordination and the provision of high-level, specialist network-related services (consultants, etc.).

The current Uninet management has defined the scarce resources as limiting these tasks and argues that the universities, polytechs and research centres are information providers in their own right. Given existing budget and staff constraints, there is a difference between what is feasible in terms of responsibilities or task and what may be desirable, including by the management itself. Added responsibilities must be coupled with new resources.

**Network monitoring and collaboration between institutions:** With the ever-increasing performance requirements of computer and networked applications playing a central role in research work, most of the current Uninet member institutions contend that there is a need for better network monitoring and maintenance on a permanent, 24x7 basis. Commercial service providers, in turn, monitor their networks permanently and can thus achieve higher degrees of stability. At the same time, some members sites have maintained the costs are already high and are reluctant to fund the cost of around the clock service, believing this is not warranted by the marginal improvement in service that would arise.

Uninet management office argues that it is unable to monitor the network on a 24x7 basis due to staff and budget constraints. It feels the various universities and polytechs, especially those at the "hub" sites, should be responsible for committing a level of their technical maintenance staff to the task of maintaining routers and other vital Uninet network services. Uninet pays the hub sites for their contribution to some of this maintenance a figure which has been agreed to by the Uninet Board.

Both Uninet management and members also point out that traditionally, when a new university or organisation joined the network, the other members in the region were prepared to pool their technical resources and expertise to establish the new Internet presence quickly and as effectively as possible. However, it has always been the assumption that the new member institution would be responsible for training its own staff as quickly as possible thereafter. This has not always been the case, especially at historically disadvantaged universities whose IT staff often does not possess the necessary networking expertise. Uninet members feel that
while they are prepared to give as much support as possible, there should be centrally organised training made available to new sites.

**Schools networking**: The load that schools networking currently places on Uninet is relatively small, with few exceptions. This is why, so far, Uninet has been able to sustain carrying the schools' traffic (also internationally) at no additional charge to the schools. With university and technikon demands becoming higher, however, Uninet strategy on this should be carefully revisited. For the interim, it appears as though the Uninet's Board perspective that it will have to start charging the school networks where possible during 1997/98 makes financial and operational sense. With the introduction of the new Uninet charge model in early 1997, the "hub" sites will begin to see the schools' traffic appear on their budget sheets as real figures and this situation needs to be prevented.

An alley to explore while most schools remain connected to Uninet might be to develop independent funding for the schools networks, coordinated, perhaps, by the newly established national schools networking coordinating body. Such funds could either be used to pay Uninet for the services rendered or to purchase own national and international bandwidth. However, it should be acknowledged that a second parallel network will face the same costs faced by Uninet from Telkom, for routers, for staff, etc, and therefore may not be more cost effective.

**Appendix: Directory of persons and institutions consulted**

This section indicates the main correspondents that were consulted. There were numerous others, either on an informal basis or those who didn't wish to be named. This applies specifically to section 3.3, "Management problems", where some of the respondents didn't wish to be named.

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