

An account of TENET's formation and activities

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Duncan H Martin
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1. TENET's origins and formation

1.1 The UNINET era

Collaborative networking between universities in South Africa started in 1987 when the late Vic Shaw persuaded the then Foundation for Research Development (now the National Research Foundation, or FRD) to manage and provide seed funding for the deployment of a network of leased lines and multi-protocol multiplexers to inter-connect a number of institutional networks across the country. This was in the days of multiple proprietary protocols, before the advent of TCP/IP, and was the beginning of UNINET. Fortunately, in terms of the telecommunications regulations of the then South African Post-Office, the universities were regarded collectively as a "common interest group", and UNINET was granted a permit to carry "third party traffic" within the group on its leased lines.

It was especially Mike Lawrie of Rhodes University in Grahamstown, Eastern Cape Province that championed the migration from proprietary protocols to Internet protocols in the early 1990's. The first such link used a 9,600 kb/s UNINET leased line between Rhodes University and the University of Cape Town in 1990. By the time Lawrie succeeded Shaw as UNINET Manager in 1994, UNINET used only Internet protocols.

Mike Lawrie and his staff in the Computer Centre of Rhodes University engineered the first connection from South Africa to the Internet in 1988 with the assistance of an American networker, Randy Bush. It was a dial-up email connection between the Control Data Cyber computer at Rhodes University and a Fidonet node located at Randy Bush's home in Portland, Oregon. The Fidonet system in the USA had a mail gateway to the Internet.

UNINET grew in bandwidth terms and provided invaluable service to the higher education and research institutions during the 'nineties. However it always had to pay full commercial prices for bandwidth, both locally and internationally, and recover these costs from the institutions. Consequently, with the emergence and rapid growth of a vibrant commercial Internet Service Provision industry in the late 'nineties, UNINET found that commercial ISPs were succeeding in attracting institutions away from it, especially in the cities. This led to doubts about the viability of continued networking collaboration and caused the NRF to reassess its role in this regard.

1.2 Events that ushered in a new era

In November 1998, the President of the NRF, Dr Khotso Mokhele, announced that the continued provision of Internet access services to other institutions was not part of the NRF's mandate and that the NRF would not continue to operate UNINET indefinitely. He told the Vice-Chancellors of universities and technikons that they should prepare for a future without UNINET.

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At much the same time, in September 1998, a group of American donor foundations led by The Andrew W Mellon Foundation expressed their concern to Telkom at the very high cost of Internet access for South African universities and technikons. The Donors were particularly concerned at the plight of academic libraries, whose services are increasingly dependent on high-speed access by patrons to information sources published electronically on the Internet. Telkom accepted the challenge and invited higher education to quantify its requirements and come to the negotiating table.

In response to these two triggers, the Committee of Technikon Principals (CTP) and the South African Universities Vice-Chancellors Association (SAUVCA) jointly formed a Technical Working Group¹ (TWG) to negotiate with Telkom and to create an alternative organisational home for academic networking in a post-UNINET era. Key requirements would be more affordable prices and to ensure a smooth transition of services and administration from UNINET to whatever new structures were created.

The entire project was known as the US Donors' Bandwidth Initiative for Higher Education.

1.3 Creating the new organisational home

After investigating various organisational options, the TWG registered Tertiary Education Network (short name: TENET) as a non-profit private company to provide an organisational home for research and higher educational inter-networking. TENET was incorporated on 22 August 2000.

A guiding philosophy with regard to structuring the new organisational home for collaborative internetworking was to avoid placing employees of the institutions, and especially institutional IT Managers, in positions of responsibility that could or would conflict with their primary responsibilities and interests within their institutions. In particular, it was felt that nothing should conflict with the primary duty of the IT Managers of the institutions to be demanding customers of TENET. Operational management of TENET should be in the hands of empowered and accountable managers; not left to collaborative processes within committee comprised of institutional representatives.

The CTP and SAUVCA each have the right to nominate four Members of TENET. Prof Brian Figaji is one of the four nominated by the CTP. These eight Vice-Chancellors, in General Meeting, constitute TENET's top decision-making body. TENET is currently preparing amendments to its Articles of Association that will enable public research institutions to participate as co-owners of TENET.

The primary collective role of the Members is to sustain the will and intention of the institutions to collaborate in the procurement of internetworking services. At each Annual General Meeting of the Company, the Members consider the annual report, the audited financial statements and the report of the independent auditors, consider any policy proposals put to them by the Board, and appoint the Board of Directors for the coming financial year.

Top-level management responsibility for TENET vests in its 9-person Board of Directors. The Board is not composed primarily so as to afford representation to specific institutional groups or lobbies, but rather as an expert Board of people who can contribute to debate and decision taking on the basis of their knowledge and experience. Only three Directors are directly associated with an institution. One of these is Prof Brian Figaji, who is the CTP's nominee to the Board. The other Directors are officers of TENET (Dr Stuart Saunders, Chairman, Dr J V Leatt, Vice-Chairman, the author as CEO) or outsiders from industry or the

¹ The TWG comprised: Dr Stuart Saunders, who represents the Mellon Foundation in South Africa, as Patron; Dr Jim Leatt, Executive Consultant of the then Adamastor Trust, as Deputy Patron; Dr Duncan Martin, then Director of Information Technology, UCT, as Convenor; Henry Watermeyer, then Director of Information Technology, University of the Witwatersrand; Dave Hulbert, Director of Information Technology, Technikon SA; André Schonken, Director of Information Technology, Port Elizabeth Technikon; Duncan Greaves, Director of Information Technology, Natal University; Emile Altona, Director of Information Technology, University of the Free State

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donor foundations. No Directors fees are paid, and these people serve on the Board because of their commitment to higher education and research. The Board has constituted an Advisory Committee comprised of IT Managers to advise it on operational matters.

1.4 Creating the contractual framework

Towards the end of November 2000, after extensive investigations by both the TWG and Telkom, and after intense, lengthy negotiations, the parties had almost reached agreement on the Higher Education Inter-networking Solution (HEIST) with Telkom. In view of this, on 30 November 2000, the NRF notified each UNINET member institution that it would terminate the UNINET services by 31 May 2001.

Telkom and TENET concluded formal negotiations with the signing on 11 December 2000 of an agreement between the NRF and TENET that provided for a smooth transition for the user institutions from UNINET to the HEIST services, and the signing on 13 December 2000 of the HEIST Agreement itself.

Immediately after the signing of these agreements, each institution was invited to enter into an Agency Agreement with TENET and to place orders through TENET for the new HEIST services, failing which, if the institution was a UNINET member, it would have six months to find an alternative Internet Service Provider. In the event, all UNINET member institutions chose the TENET option.

UNINET operations were terminated on 28 February 2001, with Telkom and UNINET ensuring the continuity of service to all former UNINET sites. Throughout the US Donors Bandwidth Initiative, the Manager of UNINET, Mr Mike Lawrie, gave invaluable technical advice and assistance.

TENET also took over from UNINET responsibility for administration of the ac.za domain and certain Autonomous Systems Numbers and Internet address ranges that are used by the institutions.

1.5 The HEIST Agreement

The HEIST agreement obliges Telkom to provide Internet access services, at agreed prices, to all UNINET user institutions and all South African higher educational and research institutions that appoint TENET as their agent for the procurement of such services. The agreement provides for Telkom to connect institutions to Internet gateways using its country-wide Public Broadband Network.

The agreement also provides for Telkom to monitor the services 24 hours per day, seven days per week, and to provide a technical help desk service directly to network managers at each institution. This so-called Customer Network Care service is provided from Telkom's new, ultra-modern National Network Operations Centre (NNOC) at Centurion.

The HEIST Agreement was seen at the time by both Telkom and TENET as having broken new ground in its inclusion of service level agreements covering times to install or upgrade services, times taken to restore faulty or degraded services (as opposed to circuits), and network latencies.

1.6 Adoption of the HEIST by the institutions

Eventually all public universities and technikons in South Africa appointed TENET as their agent and adopted the HEIST solution. In addition 13 other institutions have adopted the HEIST. These include the Human Sciences Research Council, the Medical Research Council, the National Research Foundation (including its major national research facilities such as Hartebeeshoek Radio Astronomy Observatory, the Hermanus Magnetic Observatory, the iThemba Laboratory for Accelerator Sciences and the South African Astronomical Observatory), the iZiko Museums of Cape Town and the Cape Town and

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Johannesburg sites of the National Library of South Africa. All told, HEIST services are supplied to over 80 different sites.

2. HEIST services

2.1 Service structure

When an institution orders Internet access services for a site under the HEIST Agreement, it must specify the Committed Information Rate (CIR) that it requires for each of the three different services listed in the first column of the Table 1 below. These services guarantee the availability of bandwidth on demand up to the CIR value, and permit data traffic to or from the institution to rise up to a peak information rate (PIR) equal to twice the CIR, provided that there is sufficient unused capacity on the physical links at that time.

Service	Description: Carries IP traffic between the site and...	Aggregate PIR to sites as on 15 March 2002	Aggregate PIR to sites as on 7 Sep 2004
HE Inter-networking	..other HEIST sites	16.2 Mb/s	24.8 Mb/s
National	..other South African networks	35.0 Mb/s	56.6 Mb/s
International	..other networks world-wide	64.4 Mb/s	108.1 Mb/s
Shared inter-continental circuit	..other networks world-wide	32.2 Mb/s	80.0 Mb/s

The cost of international connectivity is dominated by the cost of inter-continental bandwidth between South Africa and major carrier networks in Europe and the USA. Consequently the HEIST architecture comprises a HEIST International Gateway with a single inter-continental connection that is shared by all sites, with each site connected to the Gateway by its own dedicated circuit. This sharing allows the bandwidth of the inter-continental link to be substantially less than the aggregated peak bandwidths of the sites, taken collectively.

Telkom used geostationary satellite circuits between the USA and South Africa to carry the HEIST inter-continental traffic until 24 April 2003, since when this traffic has flowed via the United Kingdom, Portugal and the SAT-3 submarine cable. As the Figure 1 below shows, the change to terrestrial circuits dramatically improved the network latency.

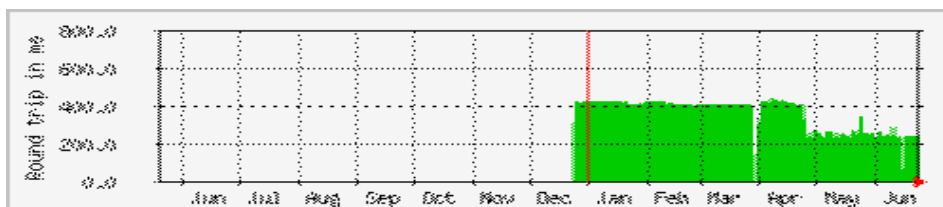


Figure 1. Ping times between Cape Town and New York; 2002/3

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The advent of SAT-3 also provided the trigger for re-negotiation of unit prices with Telkom, at which Telkom again showed its commitment to providing more affordable Internet access for the institutions.

2.2 Introduction of web caching

TENET and Telkom have tested and are about to implement a large web cache at the International Gateway. Despite the fact that many of the larger institutions already make use of a cache, the test done in march 2004 showed a hit rate on the TENET cache of 20% in volume terms. Because web traffic constitutes about 50% of total traffic, this engendered a bandwidth saving of about 10% - more than enough to justify the acquisition and operation of the cache appliance.

2.3 Remaining operational problems

Several operational problems still need to be addressed.

Spam: Despite the use of a well-known Realtime Blackhole List, a great deal of spam still wastes expensive inter-continental bandwidth and needs to be stopped at source.

Systematic congestion by some sites: Some institutions order grossly insufficient bandwidth to cope with the inbound traffic destined to their sites. This results in a lousy experience for web and other online users, and abuses the shared inter-continental bandwidth.

Ensuring fair sharing of the inter-continental bandwidth: As explained above, the amount of shared inter-continental bandwidth ordered is less than (currently about 75% of) the aggregate international bandwidth commissioned to the sites collectively. When this shared bandwidth becomes congested, an element of unfairness comes into play, in that inbound information packets get passed or dropped on a first-come-first served basis without regard to their destinations. This is unfair to institutions that have in fact ordered sufficient international bandwidth and so are not to blame for the congestion.

3. TENET's roles as Agent of the institutions

3.1 Strategic responsibilities

TENET is the signatory to the HEIST agreement with Telkom, and is responsible for keeping the agreement up to date as regards pricing, service scope and the effects of technological and regulatory change. At the time of writing, TENET is negotiating intensively with Telkom on quite major service definition, platform and pricing amendments to the HEIST agreement.

3.2 Operational responsibilities

Unlike its predecessor UNINET, TENET owns not one scrap of networking equipment and has no operational responsibilities whatsoever as regards the operation of the network or the provision of the HEIST services. Telkom does all of this.

In its role as the appointed Agent of each institution, TENET handles all interfaces and communications with Telkom on behalf of the institutions, with the exception of operational fault reporting and handling. TENET's operational roles include informing the institutions about services and prices, receiving orders from institutions and capturing all associated details into an administration system, placing the orders on Telkom, managing Telkom's performance, advising the institution when it should test installations or upgrades, and then agreeing the acceptance date with the institution and informing Telkom.

Starting from UNINET's traffic graphing system, TENET has developed an improved network traffic information system that is integrated with TENET's customer database. The system

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gathers traffic flow data from all sites (every 5 minutes, via the HEIST network) and automatically publishes graphs on TENET's web site that display the traffic flows for each service as they occur. A recent enhancement enables network managers at the various sites to view detailed traffic graphs for past days.

TENET also handles all administrative processes with Telkom on behalf of the institutions, including sending detailed monthly statements to each institution in which the charges that are due to Telkom and the agency fees that are due to TENET are set out, receiving payments of both kinds from the institutions, receiving and reconciling Telkom's invoices with the order book and, finally, making payments to Telkom on behalf of the institutions.

TENET has built operational databases and information systems to enable these processes.

TENET staff complement comprises the author, who is the CEO, Franz Dullaart, Executive Officer: Systems and Operations; Duncan Greaves, Executive Officer: Capacity Development Programs; and Mariana Swart, Technical Officer.

3.3 TENET's agency fee

TENET makes no use of the donations described below to fund its own operational expenses. These are covered through an agency fee that is charged monthly to the institutions, as provided for in the Agency Agreement. Apart from its salary and other running expenses, TENET also bears the service-monitoring fee for the Customer Network Care service from its fee income.

The agency fee is set by TENET's Board, and expressed as a percentage of Telkom's internetworking service fees. Because TENET started out with essentially no working capital, the Board initially set the agency fee at a rather high value of 14% of the HEIST service charges. This percentage has been systematically reduced and currently stands at 8%.

4. TENET's donors and donor-funded programs

4.1 The Donors

The cardinal role played by the Andrew W Mellon Foundation and other US Donors in causing Telkom, at the highest management levels, to take an interest in and negotiate a special customer-specific solution for higher education has been mentioned above. In addition, US Donor Foundations supported the initiative financially.

First, the running costs of the US Donors Bandwidth Initiative, including significant fees for legal assistance in the negotiations with Telkom, were covered by two operating grants from **The Atlantic Philanthropies** (which, at that time, acted anonymously). Over the past three years the soundness and robustness of the HEIST agreement has been proven, which would not been the case without the effort and resources that this operating grant enabled the Initiative to muster.

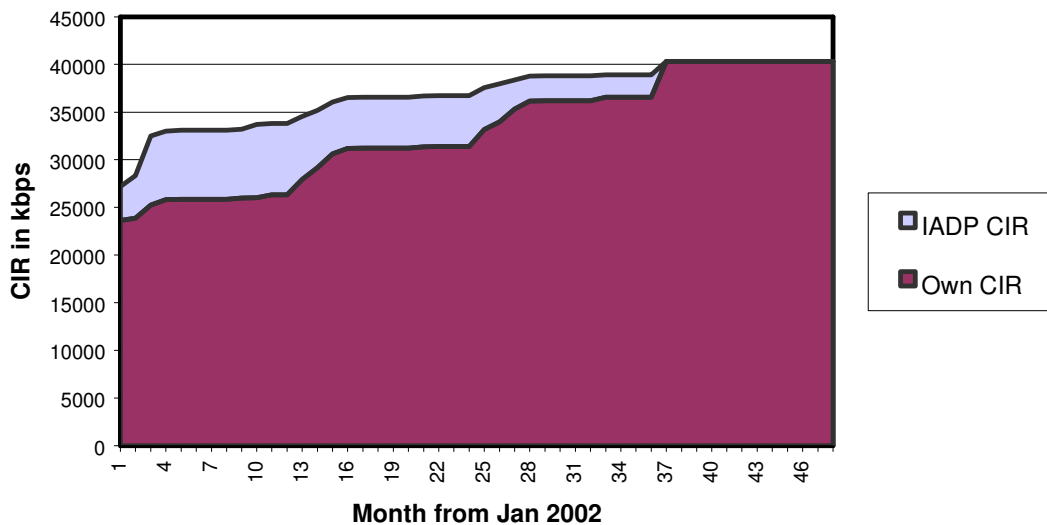
Second, on behalf of the higher education institutions in South Africa, the Initiative applied for and, in early 2001, was granted donations of US \$1 million by **The Andrew W Mellon Foundation** and €1.2 million from **The Atlantic Philanthropies**, for the purposes of purchasing additional Internet access bandwidth for the institutions and for building greater human capacity in the institutions to develop and operate their campus networks.

TENET has been responsible to the Donors for administering these latter two donations, which have been used to fund the programs described in the following two sections.

4.2 The Internet Access Development Program

The Internet Access Development Program (IADP) makes **additional** Internet access bandwidth available for specified periods to higher education institutions in South Africa. The Program sought to provide an incentive to the institutions to increase their own bandwidth budgets. It did so by offering to bear the costs of three annual tranches of additional Internet access bandwidth, conditional upon the institution making a contractual commitment to grow its own Internet access budget systematically, in accordance with certain minimum requirements, over the coming four years. The IADP agreement to which each participating institution was required to commit includes a Schedule of Orders Authorised in Advance, together with procedures for modifying this Schedule in response to changed circumstances.

Scheduled Orders of International CIR included in IADP offers made to institutions



The Program sought especially to promote increased access to the Internet by Institutions whose Internet access budgets were very limited by comparison with the then median value of around R80 000 per month.

The graph above shows the international Committed Information Rates that were specified collectively in these Schedules, broken into the self-funded component (below the lower curve) and the IADP-funded component (between the curves).

The IADP Program has worked out very much as intended, and is now nearing its end.

4.3 The DITCHE Program

The National Research Foundation (NRF) and TENET jointly conceived the *Development of Information Technology Capacity in Higher Education* (DITCHE) Program. DITCHE aims to improve the quality and effectiveness of network and other IT operations at those universities and technikons that wish to have assistance in this regard, primarily by organising and funding the development of the knowledge and skills of IT support staff and managers.

In terms of an agreement between the NRF and TENET, the DITCHE Program commenced formally on 1 February 2002. It was funded mainly by TENET and managed and executed by the NRF, which appointed Mike Lawrie as the Program Manager.

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Mike Lawrie conceived a Technical Books Project that facilitates the acquisition of technical books by institutions, particularly texts related to network management and configuration. He negotiated very significant discounts with key publishers. Mike Lawrie also arranged the first "Ditche Techie Event", which was held over three days during August 2002 in Port Elizabeth. More than eighty people participated, most of whom were IT staff members from technikons and universities. The majority of session presenters were drawn from the same group. The program itself consisted of thirty sessions, organized into three tracks. The content leaned heavily towards technical issues in network management but also included a range of general or special interest topics outside this technical domain. It had two objectives: first, to share experiences and to pass on skills; and second, to encourage human networking among the attendees. In this it was an overwhelming success and was received with acclaim by its participants.

From January 2003, following Mike Lawrie's retirement from the NRF, the DITCHE Program was reconceptualised as an exercise in the nurturing of communities of practice in three key domains within South African public higher education: IT professionals, scholars and academics committed to using IT for educational and research purposes, and library and affiliated information professionals. DITCHE activities are designed to strengthen such communities at both the technical level and the human internetworking level: there is therefore a strong emphasis on events which bring people together and forge enduring relationships of mutual support, as well as impart direct technical knowledge. A range of supplemental and supportive activities provides access to knowledge resources or problem-solving skills.

DITCHE Events in 2003 and 2004 have included four **Advanced Technical Events**, aimed at rich and structured knowledge transfer. In such events an acknowledged expert works, over a period of one or more days, with a relatively small group of people in exploring a specific issue. 2003 saw two events – one on **PHP** and one on **The Fundamentals of Network Switching**, while 2004 has seen one on **Novell eDirectory and Mergers** and one on **Microsoft Security Patch Management**. All were convincingly successful, and future DITCHE annual programs will be built primarily around a calendar of such events.

A special-purpose event was staged in October 2003 on the theme of **Bandwidth Management Strategies**. Over 50 staff representing almost all institutions gathered at a venue at the University of Pretoria for a wide-ranging conversation on this issue. Six institutions presented material on their approach to the problem, and subsequent discussion illuminated both the range of technical possibilities, and the widely divergent institutional approaches to bandwidth management.

The **2003 National Techie Event** was held at the P E Technikon Conference Centre in Port Elizabeth and again demonstrated the usefulness of bringing together a large group of technical personnel from all or most institutions. A 2004 National Techie Event is planned for October.

The **Technical Books Project** was successfully re-launched, following disappointing uptake in 2002, and to date books some R 290,000 have been distributed or made available online to institutions. The available content was also expanded through agreements with Cisco Press and Pearson Education, and with the Novell Corporation that agreed to make its self-study technical material available through the Program. Successful negotiations with Safari Books – a joint venture of O'Reilly Publishing and Pearson Education – added strongly to the Books Project, by allowing institutions access to an on-line repository of over 1400 key technical texts.

DITCHE has also arranged direct expert assistance for a number in managing intractable localised problems or in providing access to funding for training initiatives.

5. The Future

5.1 *Participating in the Global Research Network*

National Research and Education Networks (NRENs) exist in many countries, and exchange traffic at gigabit speeds via “interconnect” networks such as the European Commission’s Géant network. For some time the European Commission (EC) has been encouraging the South African Department of Science and Technology (DST) to arrange for a South African NREN to connect to Géant. Géant has very high-speed links across the Atlantic to Internet2 in the USA and Canarie in Canada, as well as to South America, to North African countries, and to research networks in the Far East. Collectively these inter-connected networks form single Global Research Network.

TENET’s Board believes that a well-configured and well-run South African NREN would provide a huge stimulus to research and the training of researchers in South Africa and strongly endorses the DST’s efforts towards establishing and funding of a South African NREN that would enable higher education and research institutions in South Africa and in neighbouring countries that have adequate terrestrial circuits into South Africa to participate in the Global Research Network. The Board further believes that TENET has the knowledge and experience to take on the tasks of making the NREN happen in design, business and contractual terms, and subsequently of driving the contractual and administrative relationships with participating institutions and with the telecommunications operators and other suppliers that would operate the NREN. Such roles would be similar to those that it plays vis-à-vis the HEIST and also similar to those played by the company Dante plc on behalf of the EC in the management of Géant.

In July 2003, the DST contracted TENET to develop an **NREN Roadmap** – a detailed plan for the creation and deployment of a South African NREN. TENET subcontracted the writing of major detailed annexures to consultants, including Prof Derek Keats and Messrs Mike Jensen, Mike Lawrie and Henry Watermeyer. The DST accepted the final report in August 2003. Subsequently the author, who was also the author of the main report within the NREN Roadmap Report, was invited to join the ministerial delegation to the IST2003 conference in Milan, Italy, where the Hon. B Ngubane, Minister of Science and Technology, presented a copy to European Commissioner Mr Erkki Liikanen.

The DST has recently authorised TENET to arrange a provisional connection to Géant from the HEIST network, for the purpose of establishing working relationships with Dante plc, the non-profit British company that operates Géant on behalf of the EC, and for enabling research groups to explore the opportunities that open up to them. The provisional connection will not entail any additional bandwidth, and will be terminated when the NREN-proper is commissioned. TENET continues to work with the DST towards the establishment of the envisaged NREN.

5.2 *Deregulation and competition*

South Africa’s Minister of Communications announced very recently significant relaxations of the telecommunications regulations that will open up and stimulate the local market. To the extent that competition forces prices down to the levels where they are transparently cost-based, the benefits to be had through consortial or collaborative procurement become less and less. Consequently, in its longer-term projections, TENET foresees a day in which its primary role could be organizing and administering the regional NREN rather than organizing general Internet access.

Much of the material in this paper is drawn from TENET’s Annual reports and other information that can be viewed on TENET’s web site at <http://www.tenet.ac.za>.