IPv6DISSemination and Exploitation

Information Society Technologies

**Project no. 015926**

**6DISS**

**IPv6 Dissemination and Exploitation**

Instrument: SPECIFIC SUPPORT ACTION

Thematic Priority 2

# D04: Report on the workshop and status of Internet connectivity in Southern Africa

Due date of deliverable: 31st January 2006
Actual submission date: 31st December 2005

Start date of project: April 1st 2005 Duration: 30 months

Organisation name of lead contractor for this deliverable: Cisco

Revision: v1.0


## Abstract

This deliverable presents a report from the workshop held in Port Elizabeth (S. Africa) from 21st to 23rd September 2005. The presentation material is listed, the attendees and their affiliations are given and the opportunities for further co-operation and follow-up actions are described.

It also includes a description of the status of the major Internet connectivity links deployed by the NRENs in the Southern Africa countries at the time of the 6DISS workshop.


| **Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)** | | |
|---|---|---|
| **Dissemination Level** | | |
| **PU** | Public | ✓ |
| **PP** | Restricted to other programme participants (including the Commission Services) | |
| **RE** | Restricted to a group specified by the consortium (including the Commission Services) | |
| **CO** | Confidential, only for members of the consortium (including the Commission Services) | |

# Table of Contents

# 1. Introduction

This deliverable presents a report from the workshop held in Port Elizabeth (S. Africa) from 21st to 23rd September 2005, in the form of a) the presentation material, b) the attendees and their affiliations, c) an assessment of the opportunities for further co-operation and follow-up actions planned, d) an analysis of the feedback questionnaire.

It also includes a description of the status of the major Internet connectivity links deployed by the NRENs in the Southern Africa countries at the time of the 6DISS workshop.

## 1.1. 6DISS Objectives

The declared objectives of 6DISS are:

1. To establish and operate a Specific Support Action of information exchange for the optimal transfer of knowledge on Internet deployment and evolution to emerging research network operators, Universities, commercial organisations, ISPs, governments and regulators in the following countries[1]:
    - The Asia-Pacific region,
    - Africa[2],
    - South and Central America,
    - Mediterranean partner countries[3],
    - Balkan countries[4],
    - Newly-Independent States (NIS)[5],
    - The Caribbean.
2. To enhance the knowledge base of the partners by exchanging deployment experiences with especially India and China.

[1] The specific countries targeted in each region have been selected on the basis that:
- the developing countries are precisely those identified by the Call,
- the countries are generally lagging behind in the deployment of broadband and preparedness for IPv6, and can therefore benefit most from the support of projects which already have the experience,
- the countries are precisely those with which 6DISS partners have very close working relationships,
- the developing countries in Europe are those that - in the longer term - might become candidates for membership of the EU, or are amongst those with which the EU has special international collaborative agreements for participation in the RTD Programmes.

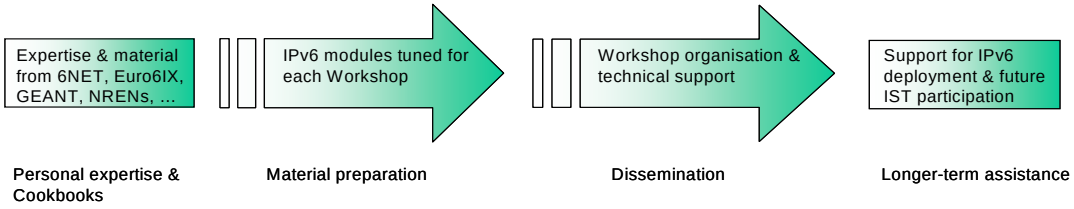
[2] Including sub-Saharan Africa, South Africa, Angola and Mozambique.

[3] Including Turkey, EUMED-CONNECT countries

[4] Including the Associated Countries of Bulgaria and Romania. Turkey and the Republic of Moldova will be invited too

[5] Including the neighbouring country of Afghanistan

Diagrammatically, the key thread of the 6DISS approach is shown following:




The target countries for 6DISS are also often ones most likely to benefit from IPv6 adoption, due to their current shortage of global IPv4 addresses.

### 1.2. 6DISS Methodology

The main mechanism for raising awareness and making the information transfer is through practical workshops to those people who are directly responsible for the installation, operation and maintenance of the National Research and Education Networks in these developing regions, and also informing strategists/decision makers in these countries of the benefits of deploying IPv6. Specific material will include how to install IPv6 versions of: DNS, DHCP, routing, multicast, QoS, renumbering, multihoming, monitoring and management, and applications. The presentation material is being improved throughout the project lifetime, taking into account feedback from the participants of previous workshops. Reports are also made available on the status of IPv6 protocols standardisation, IPv6 Forum activities, etc.

## 2. The Workshops (general)

Workshops are the main mechanism of 6DISS information transfer and collaboration-building.

6DISS has been structured to provide the ideal platform for the discussion of such deployment scenarios, and the exchange of best practices, thereby avoiding duplication of effort, wasting time on methods that are known not to work, and generally making the most efficient usage of the available resources. Partners in 6DISS are active in deploying IPv6 on a production basis in their own NRENs and University networks, and documenting the experience in Cookbooks and in IETF informational / best common practice RFCs. The manufacturers in the consortium are also building IPv6 products.

The workshops are not only intended to lead to an improved quality of the Internet infrastructure in these countries, but will also raise the competence of the organisations and - exploiting the personal contacts made through 6DISS - facilitate and encourage their participation in future FP6 Calls and beyond.

Impacts from the workshops will include:

- a positive effect in preventing the "brain drain" from developing countries, by bringing interesting and state-of-the-art activities into these regions, making information and knowledge resources accessible to the scholars both locally and globally.
- the establishment of a communication channel between the scientific communities in the targeted regions and European industry, thus resulting in an increase in the demand for the specialised services provided by the highly skilled academics and researchers of the region.
- an expansion of the conditions for growth, by enabling the exchange of ideas, launching of joint experiments and projects, disseminating RTD results, and activating market forces; all substantial elements in the process of regional development.
- making European research and industrial concerns aware of the highly skilled personnel who can contribute to the urgently needed improvement of ICT infrastructures; resulting to an increase of the demand for specialized services provided by the highly skilled academics and researchers of the region.

While IPv6 standards and services remain constant, regional variations in practices and operations will require slightly different approaches for collaboration and dissemination. Therefore, the material for this workshop was collected, and the workshop schedule, format and contents were tailored in conjunction with the local organisers, to suit the type of participants, the subjects to be addressed, the location, the host organisation, sponsors, etc.

# 3. 2nd 6DISS Workshop: Southern Africa

The Southern Africa region has been going through very dynamic and deep changes in the last decade, at all levels. This environment creates very good opportunities for initiatives such as the 6DISS workshops.

In this region, South Africa clearly has an IT edge over the other countries, and plays an important leading role in the region. Therefore, South Africa was chosen as the best target location to hold the first 6DISS workshop in the region.

Initial 6DISS contacts with representatives of TENET - *Tertiary Education NETwork* of South Africa – at the IPv6 Summit in Barcelona (June, 2005), were quickly followed by an invitation to hold an IPv6 workshop on the two days before their annual national technical event *DITCHE* – Development of IT Capacity in Higher Education, that was to take place in Port Elizabeth in September.

This was considered a good option, as it would enable the direct contact with IT experts from all South African Higher Education institutions.

All the logistics inside South Africa were dealt with by TENET, as an extension of the DITCHE conference.

## 3.1. Attendees

After deciding the location and dates, great care was taken over the correct profiling of the attendees. This was especially important in this region as major differences still exist between the various institutions.

The organisation TENET was instrumental in helping with this profiling. As was stated in the 6DISS workshop announcement[6] the target audience was defined to be: "… network administrators and architects, from institutions that have been granted an IPv6 address space assignment, or intend to apply for such an assignment in the next six months …".

Many invitations were also sent to the major research and higher education institutions in neighbouring countries. Only Angola replied, stating that they would send two persons, but unfortunately no one from Angola showed up at the event.

Initially a total of 23 persons were registered for the workshop, including representatives of:

- Two commercial ISPs (including Telkom and Internet Solutions - two major provider in South Africa)
- Four universities with strong technical backgrounds
- One university with a less strong technical background

In all cases the attendees were technical people whose knowledge about IPv6 ranged from almost no knowledge at all, to having some experience of IPv6 deployment. Some had already performed IPv6 experiments or were planning some level of deployment at their institutions.

These people are precisely the ones who will collectively determine the rate of deployment of the latest Internet technologies in South Africa, and therefore the impact will be that they will promote the upgrading of the networks to a state of the art that is comparable with EU countries. These people are also from those organisations that we wish to encourage to be active participants in future IST projects.

[6] http://www.tenet.ac.za/cdp/html/6diss.html

Through the personal contacts, and knowing more about their skills and network infrastructures, we were able to learn better how to integrate them into future project proposals.

### 3.2. Presentation material

The material presented was determined in close collaboration with the local organisers.

| Teacher | Module Name |
|---|---|
| Bernard Tuy | IPv6 Protocol |
| Bernard Tuy | IPv6 Addressing |
| Bernard Tuy | IPv6 Associated Protocols |
| Bernard Tuy | IPv6 Management |
| Janos Mohacsi | Workshop Introduction |
| Janos Mohacsi | IPv6 Address allocation case study at NIIF/HUNGARNET |
| Janos Mohacsi | Host configuration overview |
| Janos Mohacsi | Host configuration demonstration/laboratory |
| Janos Mohacsi | Routing configuration overview |
| Janos Mohacsi | IPv6 Addressing Case study : HUNGARNET |
| Janos Mohacsi | Multihoming |
| Janos Mohacsi | Deployment consideration |
| Janos Mohacsi | IPv6 Security |
| Joao Nuno Ferreira | Routing Protocols |
| Joao Nuno Ferreira | Autoconfiguration (Stateless and Statefull DHCP) |
| Joao Nuno Ferreira | IPv6 Support in DNS |
| Joao Nuno Ferreira | IPv6 Support in ccTLD .PT |
| Joao Nuno Ferreira | IPv6 Mobility |

Local equipment was made available, comprising two Cisco 1721 Routers, each with one Ethernet interface and one serial interface. Both routers were interconnected using the serial interface and were linked to the local IPv6 network by the Ethernet ones. A local Wi-Fi dual stack network was also configured with help of TENET and the Nelson Mandela Metropolitan University of Port Elizabeth.

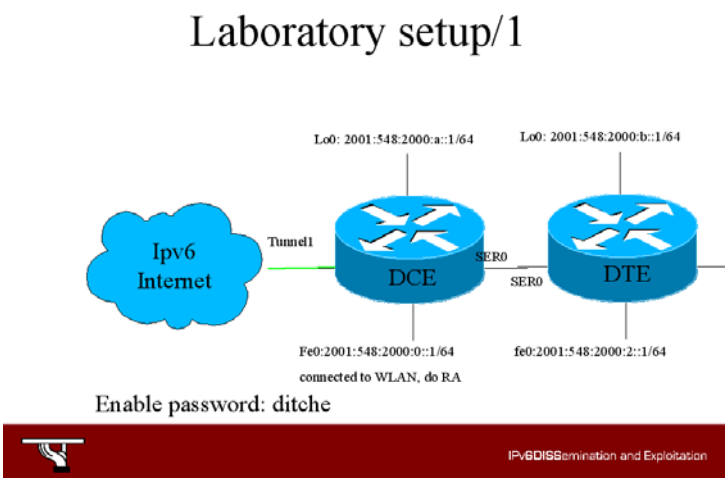



**Figure 1: Laboratory setup**

As the laboratory sessions were scheduled at the end of both days, it happened that, as the presentations took more time than anticipated, no time was left for them. Many practical questions were asked during the workshop as well in many side talks with the attendees. However, there was little interest from the attendees to "play with" the routers.

The e-learning modules were not used at this event.

### 3.3. Programme scheduling

| Teacher | Module Name |
|---|---|
| | Monday 19th |
| Joao Nuno Ferreira | Workshop Introduction |
| Bernard Tuy | IPv6 Protocol |
| Bernard Tuy | IPv6 Addressing |
| | Break |
| Bernard Tuy | IPv6 Addressing Case study : RENATER |
| Joao Nuno Ferreira | IPv6 Address allocation case study at NIIF/HUNGARNET |
| Joao Nuno Ferreira | Autoconfiguration (Stateless and Statefull DHCP) |
| Bernard Tuy | IPv6 Associated Protocols |
| | Lunch |
| Joao Nuno Ferreira | IPv6 Support in DNS |
| Joao Nuno Ferreira | IPv6 Support in ccTLD .PT |
| | Break |
| Janos Mohacsi | Host configuration overview |

| | |
|---|---|
| Joao Nuno Ferreira | Routing Protocols |
| Janos Mohacsi | Routing configuration overview |
| | |
| | Tuesday 20th |
| All | Open session of discussion and questions |
| | Break |
| Janos Mohacsi | Multihoming |
| Janos Mohacsi | Deployment consideration |
| Janos Mohacsi | IPv6 Security |
| | Lunch |
| Joao Nuno Ferreira | IPv6 Mobility |
| Bernard Tuy | IPv6 Management |
| | Break |
| All | Debrief and Conclusion |

### 3.4. Photographs taken at the event

**Figure 2: The attendees**

**Figure 3: The Teachers**

**Figure 4: The Introduction**

**Figure 5: The Router Configuration**


**Figure 6: Advanced Topic - Mobility**

### 3.5. Sponsors

The Development of IT Capacity in Higher Education (DITCHE Programme) was the local sponsor for this workshop[7]:

DITCHE's goal is to "… nurture 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. "

Their belief is that practitioners are at their most effective when they are connected to, and sustained by, communities of practice. Such networks not only foster a sense of common identity but are crucially important in the development and dissemination of knowledge (much of which is often tacit knowledge) and in solving problems that are beyond the scope of isolated individuals. Communities of practice can form spontaneously within any knowledge domain, but are especially important in deeply technical fields. They cannot generally be brought into existence artificially: a community of practice is an organic entity with a complex, volatile and autonomous internal logic. Often however they exist in latent form and may be prevented from flourishing by constraints of various kinds. One of the functions of organisational leadership and management is to identify and eliminate such constraints. DITCHE cannot eliminate internal constraints; it can however facilitate spaces within which communities of practice, latent or not, can expand. There are several ways in which it can do this - for example:

- through events which bring practitioners together to learn and to teach, to coach and to mentor, to discuss and to reflect, to share insights and vent frustrations, and to discover and reaffirm their sense of belonging to a community)
- by facilitating access to technical resources such as books and other repositories of professional information, as well as access to corporate expertise (such as speakers, training materials, reference material, and consulting)
- by facilitating problem-solving in ways that augment capacity, either directly or by freeing resources to do other things
- by acting as a repository that allows institutions and individuals to share their expertise, documents, tools and solutions with one another

### 3.6. Summary of Costs

All the costs incurred inside South Africa were supported by the local sponsor (DITCHE Programme), including local travel, accommodation, meals, facilities, etc.

[7] http://www.tenet.ac.za/cdp/html/about_ditche.html

# 4. Opportunities for further Co-operation and follow-up Actions

## 4.1. Common areas of interest

At least two domains of interest have been identified to keep in close contact with the organisations to which the attendees belong:

The first domain is related to IPv6 deployment in the networks of the participant organisations. This commitment will be supported by the 6DISS Tiger Team, which can provide "on-line" help for whatever problems the organisations may face. Examples identified in the workshop related to protocols and procedures.

The second domain of interest - that was mentioned by several attendees - is to gain experience with IPv6 multicast protocols and techniques. Due to the limited time (it was only a two-day workshop), these protocols, applications and the current status of the M6bone (a worldwide experimental IPv6 multicast network) could not be presented. However, the URL where most of the information can be retrieved, and information about how to join the M6bone project, were given[8].

## 4.2. Appropriate partners

TENET staff, acting in the framework of the DITCHE programme, are the most appropriate single point of contact to use in order to keep in touch with the workshop attendees. Moreover, as mentioned above, the 6DISS Tiger Team is the right place in 6DISS to receive any question or request for assistance from the participants or other staff from their organisations.

## 4.3. Follow-up actions

A meeting was arranged for 9th of December 2005 at the EC in Brussels to further explore the opportunities for collaboration between South African experts in Internet technology and the 6DISS project.

Some ideas that were discussed included:

- IPv6 deployment in South Africa (mainly in the Universities) with the support of the 6DISS Tiger Team
- Enhancement of IP connectivity from South Africa to Europe
- Submitting a joint proposal for the 6th IST Call, specifically relating to International Collaboration (INCO)
- Some of the more experienced South Africans have agreed to collaborate with 6DISS to deliver similar workshops in other African countries

[8] http://www.m6bone.net/

# 5. Analysis of the feedback Questionnaire

A questionnaire has been especially designed to obtain feedback from the participants, regarding the suitability of the course material and the presenters to convey the information, and the relevance of the information to the requirements of the attendees.

This section describes the contents of the questionnaire, and makes an analysis of the feedback provided.

***The participants***

The participants were mostly academic people (77%), 62% stated that their organization uses or planned to use IPv6 shortly, but 62% of the attendees were not using IPv6 at the time of the workshop.

***Topics presented***

All the modules presented got the highest mark about their usefulness. Therefore, it seems that the choice of the topics with the local organisers matched well the attendees' expectations.

***Presentation quality***

All the presentation got a "good" mark. This seems to indicate both the presenters and the material were suitable for explaining the concepts that the attendees had to understand.

More details on the workshop feedback can be found in the following tables.

B. Tuy 6DISS Workshops Sept. 19 20, 2005

**6DISS Workshop**

Port Elizabeth, ZA -19/20 September 2005

**Feedback Questionnaire**

## about the Participants

*Up to 19 participants were present at least partly. 13 questionnaires have been returned.*

| **Employment sector** | | |
|---|---|---|
| | telcos/ISPs | 3 |
| | Universities | 10 |

| **Usage of IPv6** | | |
|---|---|---|
| you use IPv6 | yes | 5 |
| | no | 8 |
| | | |
| in your organisation IPv6 is | used | 5 |
| | planned | 3 |
| | not planned | 5 |

## about the Workshop

| **usefulness of the topic** | | | | |
|---|---|---|---|---|
| | Very useful | slightly useful | not useful | useful |
| Introduction to IPv6 | 6 | 5 | | 2 |
| IPv6 Protocol | 6 | 5 | | 2 |
| IPv6 addressing | 7 | 5 | | 1 |
| Addr case study : Renater | 7 | 4 | | 2 |
| Addr case study : Hungarnet | 7 | 4 | | 2 |
| IPv6 Autoconfiguration | 8 | 4 | | 1 |
| IPv6 Associated Protocols | 8 | 3 | | 2 |
| | | | | |
| IPv6 DNS | 8 | 4 | | 1 |
| IPv6 Host configuration | 8 | 4 | | 1 |
| IPv6 Routing | 9 | 2 | | 1 |
| IPv6 Routing configuration | 7 | 2 | 1 | 2 |
| LAB-1 | 5 | 3 | 3 | 1 |
| | | | | |
| IPv6 Multihoming | 7 | 5 | | 1 |
| IPv6 Security-1 | 8 | 4 | | 1 |
| IPv6 Security-2 | 8 | 4 | | 1 |
| IPv6 Deployment considerations | 9 | 3 | | 1 |
| IPv6 Networks Management | 7 | 4 | | 2 |

B. Tuy 6DISS Workshops Sept. 19 20, 2005

| **Quality of presentation** | excellent | good | average | poor |
|---|---|---|---|---|
| Introduction to IPv6 | 5 | 8 | | |
| IPv6 Protocol | 6 | 7 | | |
| IPv6 addressing | 6 | 7 | | |
| Addr case study : Renater | 5 | 8 | | |
| Addr case study : Hungarnet | 5 | 8 | | |
| IPv6 Autoconfiguration | 4 | 9 | | |
| IPv6 Associated Protocols | 4 | 9 | | |
| | | | | |
| IPv6 DNS | 5 | 8 | | |
| IPv6 Host configuration | 4 | 7 | 1 | |
| IPv6 Routing | 5 | 5 | 1 | |
| IPv6 Routing configuration | 6 | 5 | | |
| LAB-1 | 4 | 5 | 1 | 2 |
| | | | | |
| IPv6 Multihoming | 4 | 6 | 1 | |
| IPv6 Security-1 | 5 | 5 | 2 | |
| IPv6 Security-2 | 5 | 6 | 1 | |
| IPv6 Deployment considerations | 5 | 7 | | |
| IPv6 Networks Management | 5 | 6 | 1 | |

| **Familiar with the topic ?** | None | some | most | all |
|---|---|---|---|---|
| Introduction to IPv6 | | 6 | 3 | 4 |
| IPv6 Protocol | | 6 | 4 | 3 |
| IPv6 addressing | 1 | 5 | 3 | 4 |
| Addr case study : Renater | 7 | 3 | 1 | 2 |
| Addr case study : Hungarnet | 7 | 3 | 1 | 2 |
| IPv6 Autoconfiguration | 4 | 4 | 3 | 2 |
| IPv6 Associated Protocols | 3 | 5 | 3 | 2 |
| | | | | |
| IPv6 DNS | 4 | 4 | 3 | 2 |
| IPv6 Host configuration | 4 | 3 | 3 | 3 |
| IPv6 Routing | 4 | 4 | 3 | 2 |
| IPv6 Routing configuration | 4 | 4 | 3 | 2 |
| LAB-1 | 4 | 2 | 5 | 2 |
| | | | | |
| IPv6 Multihoming | 5 | 4 | 2 | 2 |
| IPv6 Security-1 | 4 | 4 | 3 | 2 |
| IPv6 Security-2 | 4 | 5 | 2 | 2 |
| IPv6 Deployment considerations | 4 | 3 | 4 | 2 |
| IPv6 Networks Management | 3 | 4 | 4 | 2 |

B. Tuy 6DISS Workshops Sept. 19 20, 2005

| **Quality of course documentation** | |
|---|---|
| excellent | 1 |
| good | 9 |
| average | 3 |
| poor | |

| **General WS organisation** | |
|---|---|
| excellent | 3 |
| good | 8 |
| average | 2 |
| poor | |

| **Recommend to your colleagues ?** | |
|---|---|
| yes | 13 |
| no | |

| **more on the covered topics** |
|---|
| dynamic DNS & DHCPv6 |
| V6 Multicast |
| hands on |
| security & mobility implementations |
| DNS, routing, Addressing, Host conf |
| Implementation of IPv6 in an existing IPv4 net |
| managt & tools for IPv6 |
| Assignment/allocation policies |
| routing registry / RPSLng |

| **less on the Topics covered** |
|---|
| focus on differences from IPv4 |
| too many slides in Security |

| **other comments** |
|---|
| enjoyed the ws |
| more structured Xhoming discussion |
| lab session of little use |
| 3 days'd have been better: sessions too long |
| 1st day too long => 3 day-ws |

# 6. Background information about the region

As a general introduction, we can summarise that the Southern Africa region is undergoing many changes in terms of IT and connectivity development. Several initiatives are taking place at an international level as well as within South Africa. In this country the research and education infrastructures have short and/or medium term significant upgrade plans.

## 6.1. Status of Internet Connectivity

Regarding the reporting on the status of Internet connectivity, a top-down approach has been used, focusing first on Southern Africa, then on South Africa and finally on the local research and education networks and LANs.

### 6.1.1. Southern Africa

Based on the information provided by the *NEPAD Council*[9], a non-political and independent non-profit organisation founded by young African experts and professionals and in which every African state is represented, it can be concluded that the overall status of Africa's networking infrastructure is still very inadequate.

The main objective of the *NEPAD Council* is to support the *New Partnership for Africa's Development* (NEPAD)[10], a special programme created by African Heads of State and aimed at fighting poverty, consolidating democracy and good governance, fostering trade, investment, economic growth and sustainability. The highest authority of the NEPAD implementation process are the Heads of State and the Government Summit of the African Union[11].

The four highest priorities of NEPAD are:

- Information and Communications Technology (ICT),
- Communicable diseases (HIV/AIDS, malaria and tuberculosis),
- Debt reduction, and
- Market access.

Within the scope of ICT, the *NEPAD Council* has produced a paper: "Developing a fibre-optic backbone for Africa"[12] that includes an up-to-date description of present infrastructures and future plans for this continent. Parts of that document have been used for this section.

The current telecommunications infrastructure in Africa consists of a combination of radio relay links, open wire lines, radiotelephone stations, fixed local loop installations and substantial mobile cellular networks. In most African countries, mobile cellular networks have increased significantly over the past few years to overtake the number of fixed lines. For inter-state communications, satellite and microwave links are mostly used. Two African organisations administer these networks: Regional African Satellite Communication (RASCOM) and the Pan African Telecommunications Union (PATU). Despite the existence of these authorities, about 90% of African traffic is routed through Europe. African states pay about $400 million every year to have calls to other African countries routed through Europe.

[9] http://www.nepadcouncil.org/

[10] http://www.nepad.org/

[11] http://www.africa-union.org/

[12] www.corning.com/docs/corporate/discovery_center/innovation_library/2004/NTR100763.pdf

While for most African countries, connections to overseas destinations are much better than connections to other African countries, international connections are still very inadequate. There are less than 30'000 circuits interconnecting Africa with the rest of the world and most international traffic transits through Europe. Thus a significant portion of the revenue from international calls is used to pay the European network operators, thereby depriving Africans of money to upgrade their infrastructure. In addition, due to the old infrastructure, there is an additional loss of revenue due to service theft and the inability to accurately bill communication services.

Internet usage has only just begun in most of Africa and is currently concentrated in the large cities. Because of the large number of shared accounts and the high usage of public services such as Internet cafés, it is difficult to accurately determine the number of people with Internet access. However, the Internet World Statistics group estimates the average African Internet usage penetration at 1.1%. A few African countries such as South Africa, Mauritius, Seychelles, Reunion and Egypt dominate this average – the situation is much worse for most sub-Saharan African countries. The low Internet usage is affected mainly by the inadequacy and poor quality of the telecommunications infrastructure and the high cost of Internet service mostly through dial-up charged per minute. In some African countries, leaders are not supportive of the Internet for fear of the ultra freedom of communication and "cultural invasion" that it brings.

The African telecommunication status - poor infrastructure, high cost of telephone calls to other African countries, loss of telecommunication revenue to Europe and low Internet usage - can only change if a major effort is undertaken to develop a continental fibre-optic backbone to interconnect Africa and the rest of the world via current and planned undersea fibre-optic cables. The network must be planned, owned and operated by Africans.

The most successful attempt at an African fibre network so far is the two segment submarine cable system; SAFE (South Africa - Far East) which links Malaysia and India in the east to South Africa via Mauritius and Reunion and SAT-3/WASC (South Africa Trans-Atlantic - West Africa Submarine Cable) which continues from South Africa to Portugal and Spain in Europe with landings at a number of West and Southern African countries. The funding agreement for the project was signed in 1999 and President Wade, one of the founding members of NEPAD, officially launched the networks in Dakar in May 2002. The original capacity was 20Gbit/s and is upgradeable to 120Gbit/s. The 20Gbit/s is reportedly fully subscribed and is in the process of being upgraded to 40Gbit/s. The submarine cables span a total of 28,000 km and connect the countries of Portugal, Spain (Canary Islands), Senegal, Ghana, Benin, Cote D'Ivoire, Nigeria, Cameroon, Gabon, Angola, South Africa, France (Reunion), Mauritius, India and Malaysia.

A consortium of East African telecommunication organizations that include Telkom Kenya, Tanzania Telecommunications, Uganda Telecommunications, MTN and Zantel are discussing the development of the Eastern Africa submarine cable system (EASSY). This effort would complement SAT-3/SAFE/WASC and SEA-ME-WE3 to complete a ring of undersea cables around Africa. This latest African undersea cable is planned to connect SAT-3 at Mutunzini in South Africa and SEA-ME-WE3 in Djibouti. Other landing points will be in Maputo (Mozambique), Mahajanga (Madagascar), Dar es Salaam (Tanzania), Mombassa (Kenya) and Mogadishu (Somalia). Like the other cables already installed, EASSY will be a two-pair fibre cable with a proposed capacity of 16 or 32 -10Gbit/s wavelength or a maximum capacity of 320Gbit/s.

At the national and regional levels there is already significant effort to provide fibre-optic and microwave backbones. In Zimbabwe, TeleAccess is constructing a fibre-optic link between Zimbabwe and South Africa through Beit Bridge. In Southern Africa, there is an ongoing program known as the SADC Regional Information Initiative (SRII). The project involves upgrading the links between South Africa and Zimbabwe, and between Zimbabwe and Botswana and Zimbabwe and Mozambique. Some of the national/regional backbone projects have taken advantage of electricity grids, railway lines and oil

pipelines and their right of passage to install fibre-optic cable. In South Africa, the electricity parastatal ESCOM has been installing fibre along its grid in South Africa and in neighbouring countries. In Namibia, NAMPOWER is installing fibre-optic lines along all their new power lines. A number of railway operators in Southern Africa have joined forces to establish a broadband fibre-optic link from Tanzania through Malawi, Zambia, Namibia, Malawi and South Africa. The South African rail transport parastatal, TRANSTEL, is establishing a national broadband network along its railway grid in preparation for entry to the market as part of a consortium to bid for the upcoming second national operators' license.

In conclusion, the current African telecommunication infrastructure is currently in a poor state which can only be improved significantly by the installation of optical transport networks. There is a strong commitment towards building submarine and national and regional backbones in Africa.

### 6.1.2. South Africa (Republic of)

The telecom market in South Africa is still very much based on the fundamental infrastructure monopoly that Telkom, the incumbent, maintains on the provision of basic circuits. Although the provision of Internet services was liberalised, for both SOHO and the corporate markets, all providers must use Telkom circuits. The result of this is that services cost approximately 10 times those in Europe, for the commercial links that are used by NRENs. For the SOHO market, the cost disadvantage is not so great (but is still ~ 5 times more than in Europe. Additionally it is still not possible to un-bundle the local loop.

A list of all ISP can be found at the ISPA - ISP Association[13], a South African entity. There are presently 13 large size operators, 6 medium size operators and 70 small size operators.

This association also operates the only publicly advertised Internet Exchange point in South Africa, named JINX – Johannesburg Internet Exchange[14]. There are 13 operators, mostly large ones, at JINX. Like in most countries, there are also direct peering links between some operators, usually the larger ones, which bypass JINX. The aggregated traffic at the JINX amounts to daily peaks of 40Mbit/s[15].

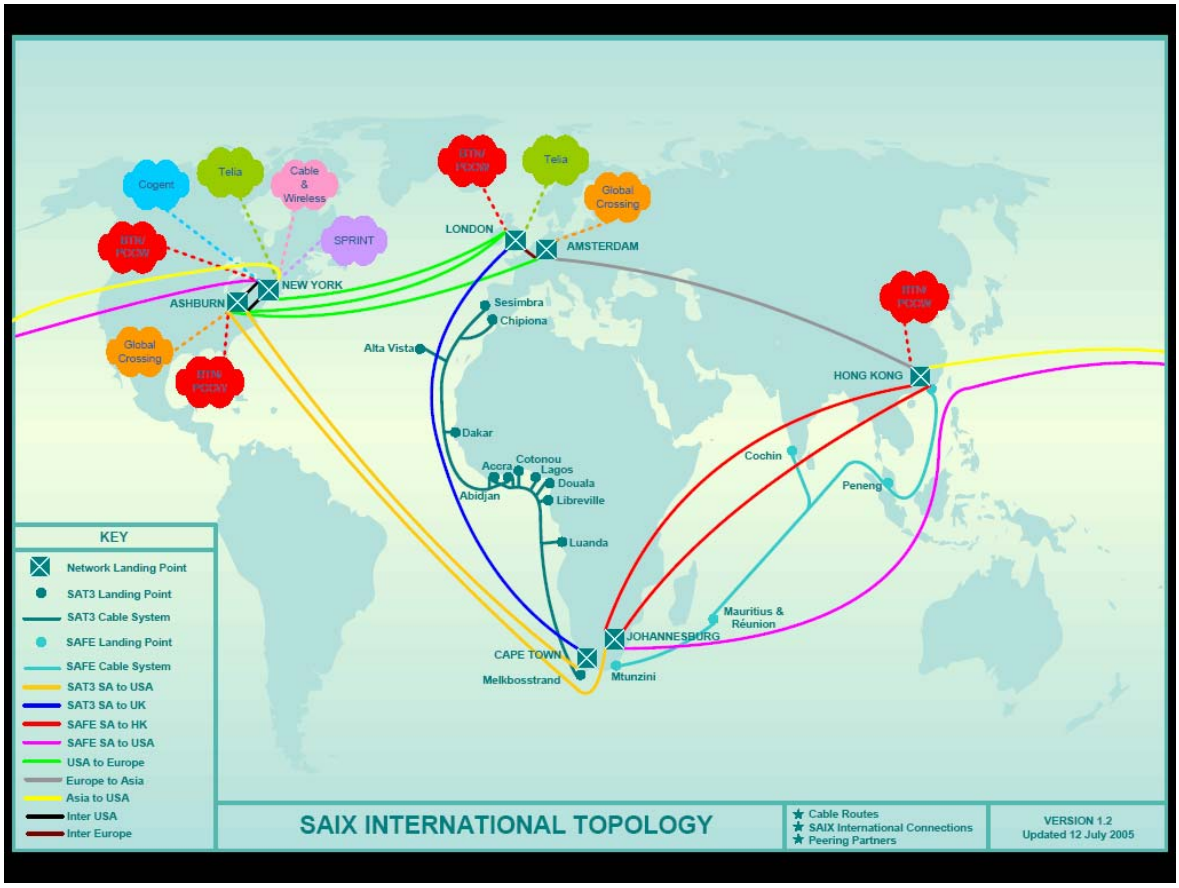
The incumbent (Telkom[16]) operates its IP services through an ISP company called SAIX – *South Africa Internet Exchange.*

[13] www.ispa.org.za

[14] www.ispa.org.za/jinx/

[15] http://stats.jinx.net.za/allports.html

[16] http://www.telkom.co.za




However, there are strong indications that this constrained environment is about to change soon, because:

- The government, through President Thabo Mbeki in his state-of-the-nation address in February 2005, stated its strong intentions to bring their telecommunications market rapidly in line with those of the OECD (Organisation for Economic Co-operation and Development) countries
- A second national operator should enter the market before July 2006. The shareholders are Tata, Two Consortium and CommuniTel, Nexus Connexion, and the state-owned enterprises Eskom (Esitel) and Transnet (Transtel). As stated before, some of these enterprises have been laying cables in preparation for this opportunity
- Two years after the entry of the second national operator, local loop un-bundling should be allowed
- New international cables are being planned and installed.

As in other regions of the world, if these steps are completed, prices should improve significantly.

### 6.1.3. TENET - South Africa NREN

The higher education system in South Africa is going through a very complex and demanding process as all urban areas that had separate institutions, under the previous apartheid regime, are now merging into single institutions. Since in most cases profound resource and infrastructure differences existed between them, the new unified organisations have to cope with huge challenges to obtain a homogenous education

and research environment, as soon as possible and with very little extra budget. This is the operational background for TENET-*Tertiary Education NETwork*, the South Africa NREN.

Presently, this network is being upgraded from an ATM-based backbone, named HEIST - *The Higher Education Inter-Networking Solution with TELKOM*, to new - more IP-based backbone - named GEN2. Both solutions are provided by the incumbent provider.

HEIST was based on ATM access links, which concentrated in a redundant IP central node with routers, managed by Telkom. It is a *collapsed star* topology. In this architecture each institution could choose 3 variables:

1. level of International capacity
2. level of National capacity
3. level of Higher Education capacity

Each one of these variables resulted in an extra price to be added to the basic connectivity cost.

The phasing out of the HEIST network is now almost completed.

The GEN2 service will be available country-wide by 31 July 2006. It is an MPLS-based solution, that supports four QoS Levels, ranging from the highest, called "Real Time (RT)", which is intended for voice and video-conferencing applications, to the lowest, called "General Data", which is just "Best-Effort". In this architecture each institution can choose the same 3 variables as above, though they are given different names.

GEN2 access speeds are still very low, when compared with similar size institutions in Europe. As an example, one of the largest universities, Cape Town, with approximately 20'000 students, has less than 20Mbit/s total access capacity to GEN2. Many institutions still have below 2Mbit/s connections, as can be seen in the on-line graphs[17].

Regarding international connectivity, GEN2 has three links:

1. A shared commodity IP international capacity of 106.3Mbit/s, which is heavily used.
2. A 10Mbit/s GRE tunnel with GÉANT, which is heavily used.
3. A 192Kbit/s link to Swaziland, which is highly saturated.

There are no regional research links to Namibia, Mozambique, Botswana, Zambia, Lesotho, Zimbabwe and Angola.

Such constrained capacities make system administrators spend a great amount of time and money managing the available bandwidth. Very complex packet shaping configurations were presented, as examples.

#### 6.1.4. SANReN - South African National Research Network

Parallel to these efforts, a new research network is being built, called SANReN - *South African National Research Network*. This is focused on meeting the network requirements of a few areas of knowledge, and a few specific institutions, such as: Astronomy, VLBI, High Energy Physics, Bioinformatics and Medical Science. Although TENET is expected to play a role in this new network, the level of operational autonomy of SANReN is not yet known.

A 1Gbit/s circuit is planned between GÉANT2 and SANReN.

[17] http://www.tenet.ac.za/mrtg-new/graphs.asp

The European Commission could be instrumental in improving the connectivity situation in Southern Africa, by initiating discussion with local governments, regarding the liberalisation of their telecommunication markets. Africa, especially South Africa, has a huge opportunity to develop their telecommunication market, that should ultimately help decrease the digital divide between the developed and developing countries.

### 6.2. Experience of IPv6

Although there is such a high costs for networking and other challenges, IPv6 activities are well under way in TENET. It became an IPv6 LIR in January 2003, from ARIN, since AfriNIC was still not operational at that time as an IPv6 RIR.

At the same time, TENET announced the following IPv6 services objectives:

" […] TENET will offer the following IPv6 services to TENET institutions:

- IPv6 inter-networking between main and satellite campuses of each TENET institution;
- IPv6 inter-networking between campuses of different TENET institutions;
- IPv6 connectivity between each TENET institution and other South African networks;
- IPv6 connectivity between each TENET institution and more than 3'000 universities and research institutions world-wide that are member institutions of various National Research and Education Networks (NRENs), via high speed connections to the European Commission's GÉANT research transit network and the Internet2 network in the USA;
- IPv6 connectivity between each TENET institution and the "commodity" Internet generally
- IPv6 Whois service for all assignments from the UNINET project IPv6 allocation
- Reverse lookup (ip6.arpa) domain name service for all assignments from the UNINET project IPv6 allocation "

During the 6DISS workshop it was clear that a good knowledge about IPv6 already exists in some ISP and higher education institutions. The TENET staff were able to quickly setup a small IPv6 LAN in the auditorium, using an IPv6 tunnel over IPv4.

The JINX exchange point is already IPv6 enabled, and publicises its IPv6 addressing plan. Two ISPs are reported to run IPv6 and peer between them[18].

Also the CCTLD .ZA already has one IPv6 glue record in the DNS root servers, as well as the .AC.ZA sub-domain, enabling any institution in TENET to request IPv6 DNS domains.

### 6.3. Ongoing IPv6 projects

The main ongoing IPv6 activities are related to the SANReN initiative, as it is planned that this will be dual stack from day one. This will be a major step forward in terms of IPv6 deployment.

A good deal of effort is also being spent in disseminating information about IPv6 to the user institutions.

Due to the merging processes referred above, some institutions are performing a major overhaul of their cabling and network services (eg. Cape Town University and Rhodes University). This is being regarded as an opportunity to become IPv6 enabled.

[18] http://www.sixxs.net/tools/grh/dfp/all/?country=za

### 6.4. Planned IPv6 activities

There is clearly a high level of interest in fostering and increasing the relationship with the European research community.

Three areas have been identified:

- Obtaining native IPv6 international connectivity, namely to GÉANT2 and the OCCAID project. (at the time of writing this report the two connections will be operational)
- Experimenting and deploying advanced IPv6 services, such as Multicast
- Supporting external lobbying and operational aspects (eg. via the Tiger Team) to speed the increase of NREN bandwidth

# 7. Conclusion

Workshops are the key mechanism through which information is being transferred by 6DISS to the targeted countries. The workshops are proving that it is possible to build constituencies, raise awareness; disseminate, benchmark and validate the research results from the IST Programme; promote recent Internet technologies; exchange best practices; and explain about activities related to standards and interoperability issues.

Cisco was formally responsible for the 6DISS workshop for Southern Africa, and was supported by the 6DISS partners: RENATER, HUNGARNET and FCCN. The workshop took place at the Nelson Mandela Metropolitan University, in Port Elizabeth and was attended by 19 participants, who were especially interested to learn of IPv6 advanced features. The material was selected according to the immediate requirements of the participants. In order to optimise travelling costs, the workshop was organised in conjunction with another TENET event: The DITCHE conference.

The set of dissemination material included all issues of Internet deployment and evolution; especially IPv4-IPv6 transition/coexistence strategies, DNS, DHCP, Routing, QoS, Mobile IP, Multicast, Renumbering, Security, Monitoring and Management tools, and Applications.

The project is aware that the workshops do not represent the end of the co-operation, but are rather only an intermediate stage towards the ultimate goal of encouraging the participation of the developing countries into the IST Programme. This goal can only be achieved by maintaining contact with the local organisers in each region, and particularly the organisations that attend the workshops. This extended contact will be stimulated by 6DISS through:

- The Tiger Team, comprising 1 expert for each topic, who will give practical operational support for configuration, bug fixes, technical queries, (via phone or e-mail) to implementers and network managers,
- A facility whereby trainers in the developing countries can be trained in Brussels or Paris on the full set of material and equipment available within 6DISS.

Opportunities for further co-operation were discussed in a follow-up meeting with 6DISS partners and the EC on the 9th December. Some ideas included:

- IPv6 deployment in South Africa (mainly in the Universities) with the support of the 6DISS Tiger Team
- Enhancement of IP connectivity from South Africa to Europe
- Submitting a joint proposal for the 6th IST Call, specifically relating to International Collaboration (INCO)
- Experienced South Africans have also agreed to collaborate with 6DISS to deliver similar workshops in other African countries

The Internet connectivity to this region is provided by TENET / Telkom but also by GÉANT, through a GRE encapsulation of IP datagrams. This role will continue beyond the workshops (and the 6DISS project).