Communications of the Association for Information Systems

Volume 19 Article 9

March 2007

Global Diffusion of the Internet XI: Internet Diffusion and Its Determinants in South Africa: The First Decade of Democracy (1994 - 2004) and Beyond

Irwin Brown
University of Cape Town, Irwin.Brown@uct.ac.za

Timothy Collins
University of Cape Town

Bantse Malika
University of Cape Town

Denzil Morrison
University of Cape Town

Nixon Muganda
University of Cape Town

See next page for additional authors

Global Diffusion of the Internet XI: Internet Diffusion and Its Determinants in South Africa: The First Decade of Democracy (1994 - 2004) and Beyond

Authors
Irwin Brown, Timothy Collins, Bantse Malika, Denzil Morrison, Nixon Muganda, and Hilary Speight

Communications of the Association for Information Systems

GLOBAL DIFFUSION OF THE INTERNET XI: INTERNET DIFFUSION AND ITS DETERMINANTS IN SOUTH AFRICA: THE FIRST DECADE OF DEMOCRACY (1994 – 2004) AND BEYOND

Irwin Brown
Department of Information Systems
University of Cape Town
Irwin.Brown@uct.ac.za

Timothy Collins, Bantse Maleka, Denzil Morrison, Nixon Muganda, and Hilary Speight
Department of Information Systems
University of Cape Town

ABSTRACT

South Africa has one of the most sophisticated information and communication technology (ICT) infrastructures in Africa, and was one of the early adopters of the Internet on the continent. This paper describes a longitudinal analysis of Internet diffusion in South Africa over the period 1994 to 2004 by making use of the Global Diffusion of the Internet (GDI) framework. It also analyses the determinants of further diffusion. The analysis shows that in 2004, at the end of its first decade of democracy, less than 10 percent of the population accessed the Internet despite its relatively wide geographic dispersion. Across the education, commercial, health, and public sectors the Internet had been largely embraced, with potential for further diffusion. The underlying national Internet connectivity infrastructure was well established. Strong competition existed between Internet service providers despite a monopoly on fixed-line telecommunications provision for much of the period. The Internet was being used for sophisticated applications in several sectors. The overall analysis reflected South Africa's reputation as having one of the most developed ICT sectors in Africa. The findings are perhaps also a reflection of its status as a middle-income developing country. After major growth in the 1990s, from 2000 to 2004 growth declined significantly. Reasons identified included the monopoly telecommunications environment over much of the period, restrictive regulation, delayed implementation of policies, and the socio-economic divide in the nation. Telecommunications policy directives announced at the end of 2004 helped in reversing the trend of stagnation that had set in.

Keywords: Internet Diffusion, South Africa, GDI Framework, ISP, Telecommunications Policy

I. INTRODUCTION

In 1994, South Africa emerged as a new democracy after years of international isolation under apartheid[1] rule. This coincided with the launch of public Internet access in South Africa

[1] "Apartheid" (or apart-ness in Afrikaans) was the official policy of the South African government between 1948 and 1990. It provided for separate living and facilities for members of the four

[Goldstuck 2002a]. 2004 marked the first decade of democracy and at the same time the first decade of public Internet usage [Goldstuck 2004c]. The Internet has the potential to contribute to development in South Africa and help bridge the socio-economic divide created by apartheid. It is instructive, therefore, to assess the diffusion of the Internet in South Africa over the first decade of democracy (1994 to 2004), and to ascertain what factors have influenced or inhibited diffusion. The Global Diffusion of the Internet (GDI) framework and methodology developed by Wolcott et al. [2001] are used to carry out the study. This framework was chosen as it has been used to assess Internet diffusion in over 40 countries, including several in Africa [Foster et al. 2004]. Such a framework allows for a broad overview of diffusion in a country to be determined and addresses the need for a consistent framework to allow for comparison between countries [Brown et al. 2004].

The GDI framework consists of six dimensions, as follows [Wolcott et al. 2001]:

- *Pervasiveness*: A function principally of the number of users per capita
- *Geographic Dispersion*: The physical dispersion of the Internet in a country
- *Sectoral Absorption*: The extent to which organisations in the academic, commercial, health, and public sectors have committed to Internet use
- *Connectivity Infrastructure*: The extent and robustness of the physical structure of the network
- *Organisational Infrastructure*: The robustness of the market and services
- *Sophistication of Use*: An assessment of what leading-edge groups of users are doing

Details of the framework are included in Appendix 1 [based on Foster et al. 2004].

Several studies have examined Internet and e-commerce use in South Africa, including the Goldstuck reports [2002a, 2002b, 2004a, 2004b], a Commonwealth policy study [CPSU 2003], the compilation of the e-business handbooks [2003, 2004], and a telecommunications sector performance review [Gillwald and Kane 2003]. This paper attempts to integrate data from these and other sources to analyse South Africa longitudinally over the decade 1994 to 2004 but this time using the GDI framework. Additionally, it assesses the determinants of Internet diffusion listed by Wolcott et al. [2001] (see Appendix 1), highlighting their relative influence in South Africa, and recommending policy changes. Policy directives announced after the bulk of this analysis was done will then be presented and assessed as to their impact.

The paper is laid out in six main sections. The first section presents background information on South Africa. In the second section, South Africa is analysed along the six dimensions of the GDI framework over the period 1994 to 2004. The third section analyses the twelve determinants of Internet diffusion in the context of South Africa. The fourth section makes recommendations for policy intervention based on the previous analyses. The fifth section examines policy directives announced toward the end of 2004 and how they address the recommendations made in the previous section. The final section reviews the key trends in Internet diffusion in South Africa since 2004 (i.e. from 2005 to 2006).

---

officially recognized [ethnic] groups. Based on empty theories of racial development, Apartheid provided the rationale for systematic denial of non-White populations' access to education, public facilities, justice, and the general trappings of modern life, including, most pertinently [for this paper], technology. Apartheid practically ended around 1990 and was officially made defunct with the democratic elections of 1994, but the effects of two generations' deprivation is still very much in evidence in South Africa almost a decade later. [Brown and Licker 2003, p. 7]

II. SOUTH AFRICA BACKGROUND INFORMATION

South Africa (see Figure 1) is a middle-income developing country which has, according to the 2001 census, a population of about 45 million [StatsSA 2003]. It has aptly been described as the "*rainbow nation,*" because of the rich tapestry of cultural, ethnic, and linguistic diversity. The four main population groups are Black South African (79 percent), White South African (9.6 percent), Coloured South African (8.9 percent), and Indian South African (2.5 percent) [StatsSA 2003]. Linguistic diversity is reflected in the 11 official languages, one of which is English. English is also the language of commerce and industry. As a result, even though only 8.2 percent of the population speaks English as a first language, many others speak it as a second, third, or even fourth language. Some key indicators of South Africa's status are displayed in Table 1.

Figure 1. South Africa Map [CIA 2004]

Table 1. Key Indicators for South Africa [CIA 2004]

Population (2001)	44,344,136
Literacy (2004)	87%
GDP (2004)	$491.4 billion
Telephone (Mainlines) (2002)	4.844 million
Telephone (Cellular) (2003)	16.86 million
Internet Users (2002)	3.1 million
Internet Hosts (2003)	288,633

South Africa's middle-income status belies the fact that there are wide income disparities between a few rich and the majority poor. The Gini coefficient is a measure of income inequality in a society, and varies from a value of 1 for total inequality to 0 for total equality [UNDP 2003]. The coefficient for South Africa is 0.635, one of the highest in the world [ANC Today 2001; UNDP 2003]. Since these disparities are as a result of past apartheid policies, they are to a large extent still ethnically based.

Comparisons between ethnic groups are still made to gauge how much progress has been made in moving away from apartheid-induced inequalities. The census conducted in 2001 provides rich data for this purpose [StatsSA 2003]. A comparison of several key census indicators between the major beneficiaries of the apartheid system (the White population), and the major victims (the Black African population) is informative [Brown and Licker 2003]. Only 5.2 percent of Black adults over 20 have higher education qualifications while 29.8 percent of White adults do. Among Black people aged between 15 and 65, 28.1 percent are unemployed as compared to 4.1 percent of White people. Only 12 percent of Black households have telephones in their dwellings, while 78.6 percent of White households do. The cell phone statistics are only slightly better: 24.6 percent of Black households have them, compared with 74.6 percent of White households. Fewer than 2 percent of Black households have a computer at home, while 46 percent of White households do. The census does not provide statistics on Internet usage, but several other studies indicate that Internet usage among the population groups follows the above pattern. De Villiers and Van Der Merwe [2001] found that at the end of 2000 only 8 percent of Internet users were Black. At this stage therefore only about 1 percent of the Black population used the Internet (similar to many developing countries), compared with about 50 percent of the White population (similar to many developed countries).

These stark contrasts led the current President Thabo Mbeki to declare that South Africa has been divided by its history into two nations – one Black and poor, the other White and rich [ANC Today 2001]. South Africa's economy has now been described as containing two sectors [SARPN 2004]. The "first economy" is characteristic of many developed world economies. The "second economy" is characteristic of many developing economies. This new terminology is perhaps reflective of the fact that there is a growing Black middle class, and that socio-economic divisions while still characterised by race are not solely race-based. This report therefore makes reference to the first and second economies of South Africa where necessary.

Goldstuck [2002a] provides a short history of Internet development in South Africa, summarized here. As with most countries, Internet development began in academic institutions in the late eighties, with the first Internet Service Provider (ISP) targeting nonacademic and commercial organisations launched in 1993. Only in 1994 was the South African public offered direct access to the Internet. By 1995 several ISPs had been established, marking the coming of age of the Internet. A more detailed history is provided by Mike Lawrie [1997], who was heavily involved in the initial stages of Internet development.

The Internet has the potential to assist South Africa in bridging the socio-economic and racial divides that still characterise the nation more than 10 years after democracy. In order to realise this potential, we need to first understand how the Internet has diffused over these 10 years and the impact of this diffusion. In the next section, a longitudinal analysis will be performed.

III. LONGITUDINAL ANALYSIS OF INTERNET DIFFUSION

A longitudinal analysis of the GDI dimensions shows how diffusion has progressed over a period. The Kiviat diagram below provides a summary of the longitudinal analysis that was conducted, with the details to follow.

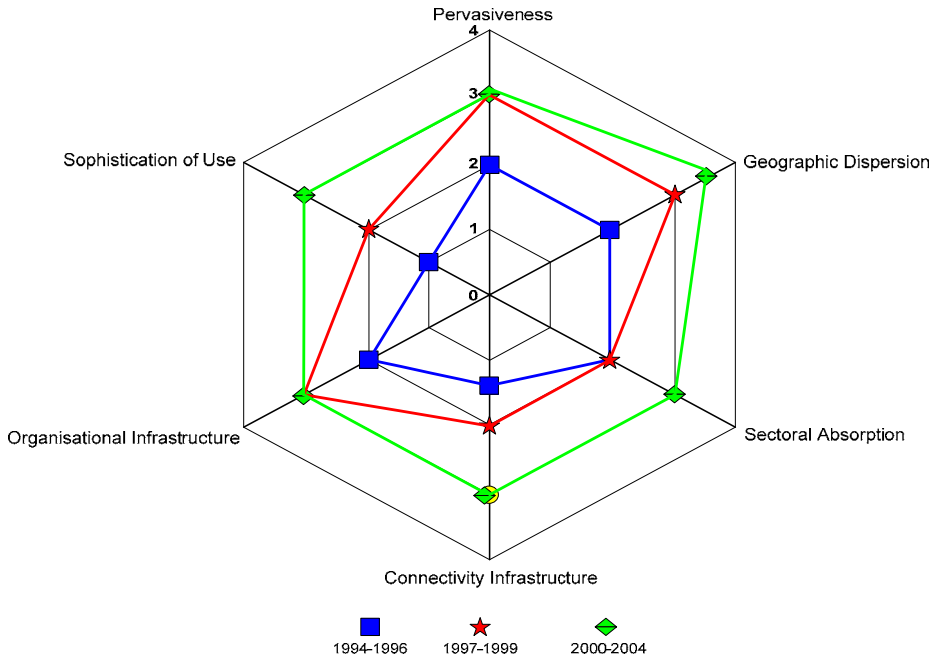


Figure 2. Kiviat Diagram, Reflecting Longitudinal Analysis

In the sections that follow, we analyze each of the six dimensions in more detail to provide evidence and rationale for the ratings shown above.

PERVASIVENESS

Table 2 describes in more detail the different levels of pervasiveness, with the 2004 level highlighted based on the analysis that follows.

Table 2. The Pervasiveness of the Internet [Wolcott et al. 2001, p.10]

Level 0	*Nonexistent*: The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country. There may be some Internet users in the country; however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1	*Embryonic*: The ratio of users per capita is on the order of magnitude of less than one in a thousand (less than 0.1%).
Level 2	*Nascent*: The ratio of Internet users per capita is of the order of magnitude of at least one in a hundred (0.1% or greater).
Level 3	*Established*: The ratio of Internet users per capita is on the order of magnitude of at least one in a hundred (1% or greater).
Level 4	*Common*: The ratio of Internet users per capita is on the order of magnitude of at least one in 10 (10% or greater)

The pervasiveness of the Internet is assessed by examining the ratio of Internet users per capita. As Jensen [2002] highlights, because of the large number of shared accounts and the use of public access services such as telecentres and cyber cafes, estimating the total number of Internet users without undercounting is very difficult. Goldstuck [2002a] points out too that some users gain access using several alternatives, such as through both home and office, which may

lead to overcounting. This overcounting may be balanced by the undercounting caused by shared use of single accounts [Goldstuck 2002a].

Table 3 summarizes the key findings of Goldstuck [2004a] on the number of Internet users in South Africa and identifies the number of users per capita based on population statistics [StatsSA 2005]. There were high Internet growth rates between 1994 and 1996 as adopters went online when the Internet first became commercially available. At this stage, users per capita were less than 1 percent (Level 2). In 1997, the number of users per capita rose above 1 percent (Level 3), and rapid growth continued into 1998 fueled by marketing campaigns of several major new ISPs [Pastore 2000]. From 1999 on, growth slowed [Pastore 2000; Goldstuck 2002a]. It reached its lowest in 2004 when growth was estimated to be only 4 percent [World Wide Worx 2005a].

Table 3. Estimated Internet Users in South Africa [Based on Goldstuck 2004a; World Wide Worx 2005a]

Year	Users	Growth	Population	% of Population
1994	100,000	150%	39,079,601	0.26
1995	198,600	98%	39,831,641	0.5
1996	354,700	78%	40,583,681	0.87
1997	696,620	96%	41,335,720	1.69
1998	1,266,235	81%	42,087,760	3.01
1999	1,820,000	44%	42,839,800	4.25
2000	2,406,000	32%	43,591,840	5.52
2001	2,886,000	20%	44,343,880	6.51
2002	3,098,000	7%	45,095,920	6.87
2003	3,283,000	6%	45,847,960	7.16
2004	3,414,320	4%	46,600,000	7.33

The state of diffusion can be analysed longitudinally by investigating three-year periods. Table 4 shows that in the formative years of 1994 to 1996 pervasiveness reached level 2, rising to level 3 in 1997. At the end of 2004, South Africa had not yet reached level 4, demonstrating the Internet's slower growth in the period 2000 to 2004.

Table 4. Pervasiveness of the Internet in South Africa (1994 to 2004)

1994-1996	1997-1999	2000-2002	2003-2004
Level 2	Level 3	Level 3	Level 3

GEOGRAPHIC DISPERSION

Geographic dispersion reflects the distribution of points of presence (PoPs) in the first-tier political subdivisions (South Africa's nine provinces). South Africa is currently at Level 3.5 as indicated by the shaded area in Table 5.

Table 5 Geographic Dispersion of the Internet

Level 0	Nonexistent. The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country. A country may be using UUCP connections for e-mail and USENET.
Level 1	Single location: Internet points-of-presence are confined to one major population centre.
Level 2	Moderately dispersed: Internet points-of-presence are located in multiple first-tier political subdivisions of the country.
Level 3	Highly dispersed: Internet points-of-presence are located in at least 50% of the first-tier political subdivisions of the country.
Level 3.5	Internet points-of-presence are located in essentially all first-tier political sub-divisions of the country
Level 4	Nationwide: Internet points-of-presence are located in essentially all first-tier political sub-divisions of the country. Rural access is publicly and commonly available.

In 1994, seven ISPs owned PoPs in at least two major cities, placing South Africa at Level 2 [Lewis 2002]. In 1996, South Africa reached Level 3 with three ISPs -- SAIX, PiX, and iAfrica -- having 20, 14, and 18 PoPs respectively in provinces throughout the country [Lewis 2002]. By 2000, PoPs were located in over 100 cities, essentially all first-tier political subdivisions [Jensen 2002].

About 42.5 percent of the population lives in rural areas [StatSA 2003], yet Internet users in the cities vastly outnumber rural users [Jensen 2002]. The first-world telecommunications network in South African cities and towns contrasts starkly with the lack of infrastructure and access in many remote rural areas [AISI 2000]. In order to counter this imbalance, several initiatives have been undertaken. Internet dial-up calls are billed at local call rates, regardless of distance, helping to reduce costs for rural access [AISI 2000]. The government established a Universal Service Agency (USA) to address telecommunications access for all, and enacted legislation that will grant licences to small and medium-sized enterprises (SMEs) to roll out services in under-serviced areas [Gillwald and Kane 2003]. Another government initiative is the establishment of Multi Purpose Community Centres (MPCCs) that offer access to telephone, fax, and Internet in disadvantaged areas [CPSU 2003]. By the end of 2005 65 MPCCs were established [GCIS 2005]. Lack of skills and capacity to implement projects coupled with delays in licensing have tended to limit the impact of some initiatives [Gillwald and Kane 2003]. As a result, although rural access is publicly available in some centres, it is not yet commonly available.

Table 6 shows that by 2004 South Africa was at Level 3.5. Although Internet PoPs exist in all first-tier political subdivisions, rural access is still not sufficiently available to justify a rating of Level 4.

Table 6. Geographic Dispersion of the Internet in South Africa (1994 to 2004)

1994-1996	1997-1999	2000-2002	2003-2004
Level 2	Level 3	Level 3.5	Level 3.5

SECTORAL ABSORPTION

The sectoral absorption dimension measures the extent to which organisations in the academic, commercial, health, and public sectors have committed to Internet use (see Table 7). Tables 8 and 9 assess sectoral absorption. The highlighted portions in Table 8 and 9 indicate South Africa's 2004 level based upon the analysis to follow. This dimension uses leased line connectivity or the presence of hosted or co-hosted Internet servers as its metrics to assess absorption [Wolcott et al. 2001].

Table 7. Major Internet-Using Sectors of the Economy [Wolcott et al. 2001, p.12]

Sector	Subsectors
Academic	Primary and Secondary Education, University Education
Commercial	Distribution, Finance, Manufacturing, Retail, Service
Health	Hospitals, Clinics, Research Centres, Physicians/Practitioners
Public	Central Government, Regional and Local Governments, Public Companies

Table 8. Sectoral Use of the Internet [Wolcott et al. 2001, p.13]

Sector	Minimal (1 point)	Medium (2 points)	Majority (3 points)
Academic	< 10% have leased-line Internet connectivity	10-90% have leased-line Internet connectivity	> 90% have leased-line Internet connectivity
Commercial	< 10% have Internet servers	10-90% have Internet servers	> 90% have Internet servers
Health	< 10% have leased-line Internet connectivity	10-90% have leased-line Internet connectivity	> 90% have leased-line Internet connectivity
Public	< 10% have Internet servers	10-90% have Internet servers	> 90% have Internet servers

Table 9. Sectoral Absorption of the Internet

Sectoral Point Total	Sectoral Absorption	Dimension Rating
0	Level 0	Non-existent
1-3	Level 1	Rare
4-6	Level 2	Moderate
7-9	Level 3	Common
10-12	Level 4	Widely Used

Each of the sectors will be analysed longitudinally within the periods 1994 to 1996, 1997 to 1999, 2000 to 2002, and 2003 to 2004 respectively.

Academic Sector

The academic sector is made up of primary schools, secondary schools, and tertiary institutions (Table 7). Available statistics are usually grouped into figures for schools on one hand (primary and secondary in aggregate), and those for tertiary institutions on the other. In the same way, this analysis will address these two major groupings – schools and tertiary institutions.

Schools

Data on school usage of the Internet is patchy. Riordon [2001] reported that only about 30 percent of the approximately 28,000 South African schools had computers, with fewer having Internet access. Goldstuck [2002a, 2004a] confirmed this low level of Internet access, reporting that in 1999 only about 500 schools connected to the Internet, giving access to approximately 30,000 learners. Thus, fewer than 2 percent of schools had Internet access, and in many instances it was dial-up connectivity rather than leased line. In 2004, the number of scholars with access was forecast at 120,000 [Goldstuck 2004a]. If a four-fold increase in scholars with access corresponds to a four-fold increase in schools connected, by 2004 at least 2,000 (8 percent) schools were connected. A news report indicates that this figure could have been as high as 8,000 [Vecchiatto 2005]. The significant increase in access from 1999 to 2004 can be attributed to initiatives by government, NGOs, parastatals, and corporations, either jointly or individually [Goldstuck, 2004a]. Goldstuck expects that government school initiatives will provide much of the impetus for further Internet growth in the next few years [Goldstuck 2004a].

Tertiary Education Sector

The development of the Internet in South Africa began in universities. Not surprisingly, access proliferated in these institutions. By 2004, all public universities and technikons (polytechnics) were connected to the Internet with leased line technology [Goldstuck 2004a]. The vast majority of South African public tertiary institutions have Internet connectivity through the Tertiary Education Network of South Africa (TENET) [Goldstuck 2002a].

Table 10 shows a longitudinal analysis of connectivity at the academic level, based on numbers of users [Goldstuck 2004a].

Table 10. Academic Users [Based on Goldstuck 2004a]

Year	Tertiary Level Users	School Level Users (Number of Schools)
1994	60,000	
1995	100,000	
1996	125,000	
1997	150,000	
1998	200,000	
1999	250,000	30,000 (500 schools ~ 2%)
2000	300,000	50,000
2001	350,000	75,000
2002	370,000	80,000
2003	380,000	90,000
2004 (f'cast)	400,000	120,000 (estimate of 2000 schools ~ 8%)

Table 10 shows that in the period 1994 to 1996, the number of academic users in the tertiary education sector more than doubled. At the end of the period there were about 125,000 academic users. At the primary and secondary school level, there was negligible usage. Given that the school sector (28,000 schools) is much larger than the tertiary, we estimate that in the period 1994 to 1996, less than 10 percent of educational institutions used leased line Internet connectivity. In the period 1997 to 1999, connectivity continued to expand in the tertiary education sector, but changed little in the primary and secondary school sector. We estimate that Internet connectivity remained at less than 10 percent during this period. From 2000 to 2002, growth in connectivity in the tertiary sector continued, albeit at a slower rate, while the number of school users online grew from about 30,000 in 1999 to 80,000 in 2002. Not all schools employed leased line connectivity, and connectivity probably remained at less than 10 percent during the period. By 2004, almost all tertiary institutions had leased line Internet connectivity, and about 120,000 users had access at schools. These schools were estimated to represent at least 8 percent of the total number. This contrast of about 100 percent leased line connectivity in tertiary institutions and about 8 percent connectivity in schools justified a rating of medium level absorption for the period 2003 to 2004. Table 11 summarizes these findings.

Table 11. Academic Sector Absorption

1994-1996	1997-1999	2000-2002	2003-2004
Minimal	Minimal	Minimal	Medium

Commercial Sector

Table 8 indicates that data on Internet servers ought to be gathered to assess diffusion in the commercial sector. Wolcott et al. [2001] state that leased line connectivity may be used as a surrogate. The total number of businesses needs also to be known to determine what percentage has leased-line Internet connectivity. A UCT report [2002] stated that there were 906,690 enterprises in South Africa, of which 60,167 had more than 200 employees and more than $10 million turnover (i.e. large in size). This sector contributed 65.2 percent to GDP [UCT 2002]. Many smaller businesses tended to opt for dial-up and other types of connections with large businesses being the primary users of leased lines. A 2003 report, for example, stated that 64.8 percent of small businesses chose access via a basic modem (dial-up) connection [Business Day 2003]. The next most popular connection, with 19.0 percent penetration, was an ISDN line. Leased lines were the third-most popular at 10.5 percent penetration [Business Day 2003]. In this study, leased line connectivity will be compared with the number of large organizations to gain a reasonably optimistic estimate of commercial leased line connectivity.

Using the statistics provided by Goldstuck [2004a] on the growth of corporate leased lines since 1994, we can analyze the growth longitudinally and compare their number to the total number of large corporations in the commercial sector. Because of the benign economic growth between 1994 and 2004, we assume that the number of large businesses remained relatively constant at about 60,000 [UCT 2002]. Table 12 shows the ratio of leased lines to large businesses in each year between 1994 and 2004. Between 1994 and 1996 the ratio was less than 1 percent. From 1997 to 1999 it was about 8 percent, and between 2000 and 2002 the ratio went above 10 percent. In the final period (from 2003 to 2004) the growth trend continued, but was far from reaching the 90-percent threshold.

Table 13 shows how the percentages of Table 12 translate into the measures for sectoral absorption of the GDI framework. We estimate that from 1994 to 1996, the sectoral absorption was at less than 1 percent, rising to 8 percent in the period 1997 to 1999. In the period 2000 to 2004, we estimate that the 10 percent barrier was broken, pushing South Africa into the medium category.

Table 12. Internet Access via Leased Lines [Based on Goldstuck 2004a]

Year	Corporate Leased Lines	Ratio of Large Business to Leased Lines
1994	125	0.2%
1995	325	0.5%
1996	750	1.2%
1997	1750	2.9%
1998	3500	5.8%
1999	4900	8.1%
2000	6370	10.6%
2001	7148	11.9%
2002	8620	14.3%
2003	10760	17.9%
2004 (f'cast)	12900	21.4%

Table 13. Commercial Sector Absorption

1994-1996	1997-1999	2000-2002	2003-2004
Minimal	Minimal	Medium	Medium

Public Sector

The South African public sector consists of three main layers: the national, provincial, and local government [GovZA 2003]. Several state-owned enterprises (or partially state-owned) (SOEs) are prominent enterprises that have sophisticated ICT infrastructures, e.g., Telkom (the national fixed line telecommunications provider), Eskom (the electricity utility), and Transnet (transport services).

The literature search yielded no direct evidence of number of Internet servers or of leased lines in this sector. Anecdotal evidence suggests that leased line access and use of Internet servers are fairly widespread. Almost all government departments and SOEs have a Web presence [GovZA 2003], and there are plans to implement e-government services [James *et al*. 2000; DPSA 2003]. Goldstuck [2002a] reports that some SOEs have as many as 4,000 to 20,000 users sharing a leased line. James et al. [2000] point out that there were about 100,000 Internet-enabled PCs in the public sector in 1998, 10 percent of the total for the formal employment sector [Molla 2002]. The total number of employees in the public sector was estimated to be about 1 million [GCIS 2003]. The ratio of Internet-enabled PCs to employees was therefore approximately one to ten. We infer then that during the period 1997 to1999 the ratio reached 10 percent. Longitudinal data prior to 1998 are not available, so we estimate that during the earlier period of 1994 to 1996 absorption was minimal, rising to medium in the 1997 to 1999 period, and remaining at that level through 2004.

Table 14. Public Sector Absorption

1994-1996	1997-1999	2000-2002	2003-2004
Minimal	Medium	Medium	Medium

Health Sector

Louw and Hanmer [2002] conducted a study on the penetration of ICTs in the South African healthcare sector, both public and private, at all levels of care (primary, secondary, and tertiary). The study indicated relatively low usage of both leased line and dial-up Internet connectivity. Large organisations tended to have leased line access, while smaller organisations such as clinics, tended to rely on dial-up access. Some organisations used a combination of leased line and dial-up access. The level of ICT diffusion varied considerably between the public and private sector healthcare services, with Internet connectivity more common in the private healthcare systems [Louw and Hanmer 2002]. The greater level of resources in private healthcare systems translates into greater spending on ICT services [E-business Handbook 2004]. Private healthcare providers were among the early adopters of ICTs, and continue to innovate with e-business for the purpose of, for example, claims submissions [e-Business Handbook 2004].

Absorption in the health sector tends to mirror absorption in other sectors. Given the lack of statistics, a longitudinal analysis of the health sector must rely on the trends observed in the commercial and public sectors, of which the health sector is a part. If this assumption holds, absorption in health care was probably minimal from 1994 to 1999. In the period 2000 to 2004, we estimated that the level of absorption was medium in both the public and commercial sectors. We expect this trend held also in the health care sector. Table 15 summarizes this longitudinal analysis.

Table 15. Health Sector Absorption

1994-1996	1997-1999	2000-2002	2003-2004
Minimal	Minimal	Medium	Medium

Overall Sectoral Absorption

Table 16 highlights the longitudinal overview of all sectors, indicating a moderate increase over the period 1994 to 2004. Growth stabilized at level 3 and will remain there until at least two sectors achieve 90 percent leased line connectivity.

Table 16. Sectoral Absorption of the Internet in South Africa (1994-2004)

	1994-1996	1997-1999	2000-2002	2003-2004
Academic	Minimal (1)	Minimal (1)	Minimal (1)	Medium (2)
Public	Minimal (1)	Medium (2)	Medium (2)	Medium (2)
Commercial	Minimal (1)	Minimal (1)	Medium (2)	Medium (2)
Health	Minimal (1)	Minimal (1)	Medium (2)	Medium (2)
Sectoral Absorption	Moderate (4) (Level 2)	Moderate (5) (Level 2)	Common (7) (Level 3)	Common (8) (Level 3)

CONNECTIVITY INFRASTRUCTURE

Connectivity infrastructure assesses the extent and robustness of the physical structure of the network by looking at the aggregate bandwidth of the domestic and international backbones, the number and type of interconnection exchanges, and the type and sophistication of local access methods being used [Wolcott et al. 2001]. South Africa is currently at level 3 as indicated by the shaded portion of Table 17 below.

Table 17. Connectivity Infrastructure of the Internet

		Domestic Backbone	International Links	Internet Exchanges	Access Methods
Level 0	Non-existent	None	None	None	None
Level 1	Thin	<=2 Mbps	<=128 Kbps	None	Modem
Level 2	Expanded	> 2Mbps -200 Mbps	> 128 Kbps -45 Mbps	1	Modem 64 Kbps leased lines
Level 3	Broad	> 200 Mbps – 100 Gbps	> 45 Mbps - 10 Gbps	More than 1; Bilateral or Open	Modem > 64 Kbps leased lines
Level 4	Extensive	> 100 Gbps	> 10 Gbps	Many; both Bilateral and Open	< 90% modem > 64 Kbps leased lines

Domestic Backbone

All domestic connectivity is handled by Telkom [Gillwald and Kane 2003]. A study by Gilfillan and Shick [1999] estimated that South Africa had approximately 250 Mbps of domestic bandwidth in 1999 (Level 3). We estimate that South Africa's domestic bandwidth did not increase by a factor of 400 by 2004 and remained under the 100 Gbps required for Level 4 maturity.

International Links

In 1994, South Africa had over 128 Kbps of international bandwidth, but less than 45 Mbps, which placed it at Level 2 [Lewis 2002]. Lewis [2002] furthermore indicates that total outbound bandwidth was 40 Mbps (Level 2) in 1998, 90 Mbps (Level 3) in 1999, 150 Mbps (Level 3) in 2000, and 343 Mbps (Level 3) in 2002 [Lewis 2002]. The ISPMAP [2004] shows that at the end of 2004 South Africa had over 800 Mbps of international bandwidth, which still placed it at Level 3 (Broad).

Internet Exchanges

In 1994, South Africa had no Internet exchanges (INXs), so traffic between local ISPs had to be routed overseas. South Africa was at Level 1 (Thin). When the ISP Association of South Africa (ISPA) created two bilateral Internet Exchanges -- the Johannesburg Internet Exchange (JINX) and Cape Town Internet Exchange (CINX) -- in 1996 and 1997 respectively South Africa reached Level 3 [Lewis, 2002]. In mid-2004, CINX was shut down due to a lack of demand [Balancing Act 2004], and the country fell to Level 2 again with regard to Internet exchanges.

Access Methods

The access methods variable assesses the percentage of users who employ modems to access the Internet rather than other high bandwidth means such as ADSL, and also the availability of

leased lines with greater than 64k capacity [Wolcott et al. 2001]. In 1994, South Africans were able to access the Internet via standard leased lines and modems. Telkom, the fixed line provider, also introduced ISDN services [Telkom 2006]. The rating for access methods was at level 2. In 2002, Telkom launched ADSL services [Telkom 2006]. At this stage, home access was predominantly via dial-up modem. The availability of high speed leased lines merited a rating of level 3. In the period 2003 to 2004, additional broadband services were introduced, such as wireless broadband from Sentech [Goldstuck 2004a]. Among small and medium-sized enterprises (SMEs) (less than 200 employees) modems accounted for only 22 percent of access, with ISDN (25 percent) being the most popular access method [Goldstuck 2004a]. About 24 percent of SMEs used leased lines with 64k capacity, with about 25 percent using leased lines with higher capacity [Goldstuck 2004a]. Over the period 2003 to 2004, modems were still the predominant mode of access for home users given the high costs of the alternatives. The rating for access methods therefore remained at level 3.

Table 18. * Connectivity Infrastructure of the Internet in South Africa (1994-2004)

	1994-1996	1997-1999	2000-2002	2003-2004
Domestic Bandwidth	1	2	3	3
International Bandwidth	2	2	3	3
Internet Exchanges	1	3	3	2
Access Methods	2	2	3	3
Aggregate level	1.5	2	3	3

* Numbers refer to GDI framework dimension levels in Table 17

Table 19. Organisational Infrastructure of the Internet

Level 0	None: The Internet is not present in this country
Level 1	*Single*: A single ISP has a monopoly in the Internet service provision market. This ISP is generally owned or significantly controlled by government
Level 2	*Controlled*: There are only a few ISPs and the market is closely controlled through high barriers to entry. All ISPs connect to the international Internet through a monopoly telecommunications service provider. The provision of domestic infrastructure is also a monopoly
Level 3	*Competitive*: The Internet market is competitive. There are many ISPs and low barriers to market entry. The provision of international links is a monopoly, but the provision of domestic infrastructure is open to competition, or vice versa.
Level 4	*Robust*: There is a rich service provision infrastructure. There are many ISPs and low barriers to market entry. International links and domestic infrastructure are open to competition. There are collaborative organisations and arrangements such as public exchanges, industry associations, and emergency response teams.

ORGANISATIONAL INFRASTRUCTURE

The organisational infrastructure dimension evaluates the robustness of the Internet industry [Wolcott et al. 2001]. It is evaluated by providing a measure of the competitiveness of the market for Internet and telecommunications services [Foster et al. 2004]. Table 19 provides an overview of the organisational infrastructure dimension and the characteristics of the different levels [Wolcott et al. 2001]. The shaded portion indicates South Africa's level in 2004.

Competitiveness of the Market

Prior to 2002, the national fixed line telephone operator, Telkom, had a monopoly in the provision of fixed line telecommunications services [Goldstuck 2002a]. A second national operator (SNO) was approved in 2002, but by 2004 had not yet begun operations [E-business Handbook 2004]. At this stage, although there was competition in the ISP market, ISPs were required to source their fixed line connectivity requirements from the national operator (or SNO when operational) - a situation that stifled innovation in the industry [Gillwald and Kane 2003]. For example, ISPs were not able to provide voice communication services as it was the preserve of the national operators. Thus, the potential for ISPs to provide VoIP was stifled [Gillwald and Kane 2003].

In May of 2004, a company called Sentech began to rollout IP-wireless technology in order to provide broadband wireless Internet [Sentech 2004]. This heralded the beginning of competition with Telkom and other ISPs in the provision of broadband Internet connectivity [Goldstuck 2004a]. The mobile operators, of which there were three in 2004 -- MTN, Vodacom and Cell C --, were also very much aware of the potential for the provision of data services through their mobile networks. The huge success of text messaging (SMS), and the uptake of WAP among the up-market segment lead MTN and Vodacom to launch GPRS and 2.5G (always-on) data services [Gillwald and Kane 2003]. This was with an eye toward the subsequent rollout of 3G services, and hence broadband Internet connectivity [Gillwald and Kane 2003].

ISP Size

The major categories of ISP in South Africa are [Goldstuck 2002a]:

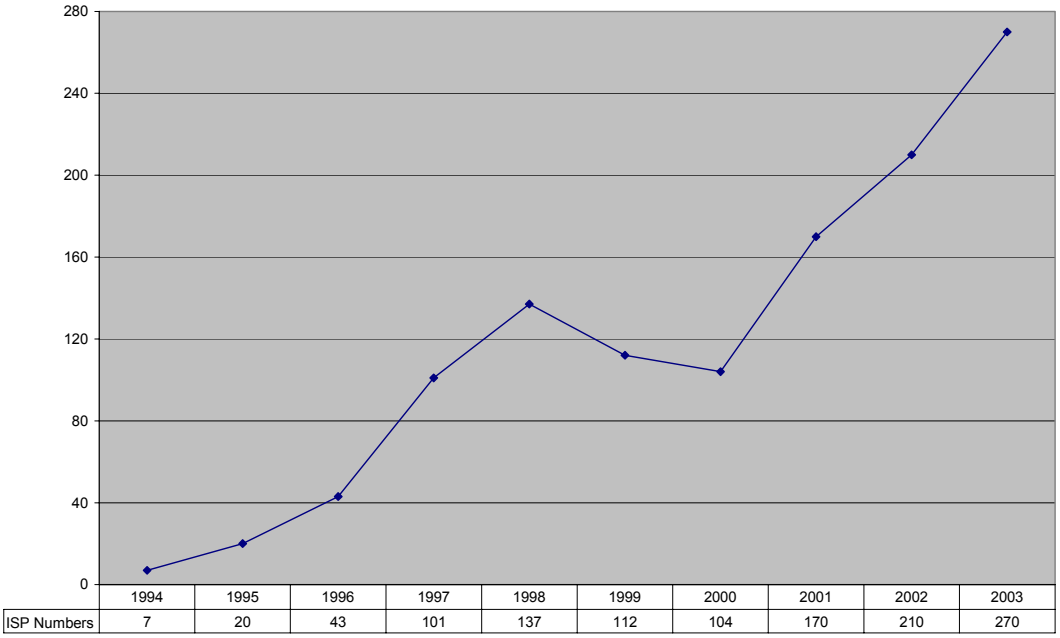
- Internet Access Providers (IAPs) - usually providers of high-speed bandwidth
- ISPs – those having their own infrastructure
- “Semi-virtual” ISPs - those using both their own PoPs, but IAP dial-in nodes
- “Virtual” ISPs - those using IAP dial-in nodes.

Telkom operates the South African Internet eXchange (SAIX), which is the largest Internet Access Provider (IAP) and owns the largest international backbone infrastructure [Telkom 2003]. It provides raw first-tier Internet connectivity to corporate and ISP companies, and specialises in the access and delivery of international, national long-distance and local IP traffic [Telkom 2003]. Goldstuck [2002a] reports that there were 170 ISPs as at 2001, inclusive of all the above categories. International bandwidth was provided for by about four organisations, including the national operator (Telkom), through its subsidiary SAIX [Goldstuck 2002a]. The number of ISPs grew significantly between 1994 (7) and 1998 (137), before a slow-down [Goldstuck 2002a]. The slow-down in growth was caused by consolidation in the industry. Larger ISPs took advantage of economies of scale to provide cheaper value added services [Goldstuck 2004a]. The introduction of Virtual ISPs by IAPs Internet Solutions (IS) and SAIX in 2001 again stimulated the ISP market as barriers to entry (the high infrastructure costs for bandwidth) were removed [Goldstuck 2004a]. Table 20 highlights the growth in ISP numbers between 1994 and 2003.

Existence of Organisational Bodies

Another measure of competition in the industry is the existence of organisational bodies, which lobby for the interests of their members [Wolcott et al. 2001]. In South Africa, there has been collaboration between ISPs in the form of action groups promoting the ISPs’ interests: On the 10th of June 1996, the Internet Service Providers Association (ISPA) was formed [ISPA 2005]. It lobbied against the formation of SAIX, which saw Telkom’s entry into the ISP market. In November 1996, the SAIX ISPs Action Group (SIAG) was formed to promote the interests of the ISPs connected to SAIX [Lewis 2002; 2004]. Both of these bodies still exist and actively promote the interests of ISPs.

Table 20. ISP Growth for 1994 to 2003 [Based on Goldstuck 2004a]



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
ISP Numbers	7	20	43	101	137	112	104	170	210	270

The ISP industry in South Africa is very competitive and due to the virtual ISP program of Internet Solutions and SAIX, barriers to entry in the market are very low [Goldstuck 2004a]. The virtual ISP programs allow ISPs with no backbone infrastructure of their own to make use of the dial-in nodes of Internet Solutions and SAIX. All major ISPs in the industry are also maturing into Application Service Providers (ASPs), which further illustrates the strength of the ISP industry [Goldstuck 2004a]. As at 2004, even though the fixed-line provider was still operating as a *de facto* monopoly, the existence of alternative wireless providers coupled with the low barriers to entry in the ISP industry justified a rating of level 3 for the organisational infrastructure dimension.

Table 21 provides a longitudinal overview of South Africa's organisational infrastructure dimension between 1994 and 2004. The table illustrates that due to the high growth in ISP numbers between 1996 and 1997 (130 percent), the industry was rated as competitive (level 3) from 1997, although Telkom had a monopoly on fixed line provision. The formation of organisational bodies overseeing the industry in the same period also led to South Africa's level 3 ranking. South Africa remained at level 3 from 2000 through to 2004, due to the continued Telkom monopoly despite the approval of a SNO in 2002. Movement to level 4 requires the introduction of greater competition in the ICT industry, and rapid implementation of new liberalisation policies.

Table 21. Organisational Infrastructure in South Africa (1994 to 2004)

1994-1996	1997-1999	2000-2002	2003-2004
Level 2	Level 3	Level 3	Level 3

SOPHISTICATION OF USE

The sophistication of use dimension examines innovation with regard to Internet use in a country [Foster et al. 2004]. Table 22 below provides an overview of the dimension with the highlighted portion indicating the 2004 level based on the analysis to follow. In our analysis, sophistication of use among individual users will be examined first, followed by usage in business.

Table 22. Sophistication of Use of the Internet

Level 0	*None*: The Internet is not used, except by a very small fraction of the population that logs into foreign services
Level 1	*Minimal*: The user community struggles to employ the Internet in conventional, mainstream applications
Level 2	*Conventional*: The user community changes established practices somewhat in response to or in order to accommodate the technology, but few established processes are changed dramatically. The Internet is used as a substitute or straightforward enhancement for an existing process (e.g. email vs. post). This is the first level at which we can say that the Internet has "taken hold" in a country.
Level 3	*Transforming*: The use of the Internet by certain segments of users results in new applications, or significant changes in existing processes and practices, although these innovations may not necessarily stretch the boundaries of the technology's capabilities.
Level 4	*Innovating*: Segments of the user community are discriminating and highly demanding. These segments are regularly applying or seeking to apply, the Internet in innovative ways that push the capabilities of the technology. They play a significant role in driving the state-of the-art and have a mutually beneficial and synergistic relationship with developers.

Individual-Level Use

In 1994, public access to the Internet became a reality in South Africa [Goldstuck 2002a]. By 2001, Web user behaviour was described as "characteristic of an Internet community that is building rapidly, and has yet to reach maturity" [Nielson//NetRatings cited by Goldstuck 2001]. At this time, about 47 percent of the online community were thought to have engaged in e-commerce [De Villiers and Van Der Merwe 2001]. Online retail sales in 2001 (excluding car, property, and travel) amounted to ZAR 162 million, just 0.1 percent of total retail sales in South Africa [Goldstuck 2002b], and rose to ZAR 340 million in 2003 [Goldstuck 2004b]. Internet banking in like manner grew rapidly, and by 2004 about one of three Internet users subscribed to this service [World Wide Worx 2004].

Cell phone services were coincidentally launched at about the same time as public Internet use in 1994 [Telkom 2006]. The rapid growth that characterised cell phone uptake was not accompanied by the same growth in Internet access via these devices [Goldstuck 2002a]. Cell phone banking adoption, for example, was initially slow [Brown et al. 2003]. The e-Business Handbook [2003] put the number of users of this service at about 100,000 - one tenth the number of Internet banking users. This gave an indication of a small but significant group of early adopters who embraced leading-edge technologies and applications. 2.5G services via GPRS-enabled devices had early adopters, as well as ADSL, broadband wireless, hot spots, interactive digital TV, t-commerce, and 3G [e-Business Handbook 2004; Gillwald and Kane 2003]. Early adopters of new cell phone services were mainly subscribers with contracts. These contract subscribers made up only about 10 percent of all cell phone users and were mainly middle to upper income earners [e-Business Handbook 2004]. The majority prepaid cell phone subscribers were less likely to have access to these newer data services, thus the digital divide still persisted.

Organisation-Level Use

Molla [2002] in a survey of South African commercial organisations found that 9 percent were connected to the Internet but had no Web presence, 29 percent had a static Web site, 41 percent had interactive sites, 17 percent transactive and 4 percent integrated sites. Thus, there were a few leading-edge organisations integrating their Web sites with suppliers, customers, and partners, allowing most of their business to be conducted through the Internet.

Some of the key trends in the South African e-commerce environment post 2000 were [BMI-T cited in CPSU 2003]:

- Attempts by local vendors to focus sales efforts abroad at more mature markets;
- Outsourcing of IT services;
- A decline in the number and size of e-business solution providers;
- e-procurement, e-CRM and e-billing driving growth;
- Revenue from non-access services growing faster than access-related revenue;
- Growing use of Internet technology in non-Internet environments;
- Growing recognition of the role mobile devices play, although m-commerce adoption and development were slow;
- The introduction of interactive TV and t-commerce.

Goldstuck [2004a] noted too that wireless broadband, net acceleration applications, and power line connections were all likely to be embraced as alternative access channels beyond 2004. These trends pointed to increasing levels of sophistication, as new technologies and applications were embraced, especially by corporate business [Goldstuck 2004a].

In the government sector, South Africa has an ambitious ten-year plan for implementing e-government [DPSA 2003]. Six phases are envisaged - Phase 1 involves ensuring provision of information, through multiple channels, while Phase 2 will allow for two-way transactions. As a consequence almost all 34 government departments have their own Web site, indicating Phase 1 is well underway. The South African Revenue Service allows for e-filing of tax returns, indicating phase 2 is also in process [The e-Business Handbook 2003]. Phase 3 (multi-purpose portals), Phase 4 (personalised portals per citizen), Phase 5 (clustered government e-services), and Phase 6 (comprehensive transformation) were still to be implemented.

Table 23 shows a longitudinal analysis, illustrating the progression of the sophistication of use of the Internet from 1994 to 2004. In the period 1994 to 1996, the Internet was just being realised and had not yet become a mainstream commodity. It was therefore characterised as being at Level 1. Between 1997 and 1999, the Internet grew substantially, and it was slowly being incorporated into business processes. This period can therefore be characterised as being at Level 2. Between the period 2000 and 2002, the Internet was beginning to change the way business was conducted and new applications were being developed to increase its impact. Therefore level 3 indicated the position of the Internet in South Africa at the time. Due to inherent weaknesses in the structure and regulation of the South African telecommunications sector [Gillwald and Kane 2003] by 2004 it was not yet at the point of being innovative (level 4) in the use of the Internet.

Table 23. Sophistication of Internet Use in South Africa (1994 to 2004)

1994-1996	1997-1999	2000-2002	2003-2004
Level 1	Level 2	Level 3	Level 3

LONGITUDINAL ANALYSIS OF ALL DIMENSIONS

As the summary of the dimensions in Tables 24 and 25 illustrate, South Africa progressed significantly along the dimensions from 1994 until 2000. Internet diffusion then stagnated in all of the dimensions to 2004. Much of this stagnation was attributed to the monopoly telecommunications environment, restrictive regulation, delayed implementation of policies, and the socio-economic divide in the nation [Goldstuck 2002a; Gillwald and Kane 2003].

Table 24. South African Dimensions for 2004

Dimension	Level	Comments
Pervasiveness	Level 3: Established	There were approximately 3,414,320 Internet users in South Africa.
Geographic Dispersion	Level 3.5: Highly dispersed	There were PoPs in over 100 cities and in all nine provinces, but rural access was still scant.
Sectoral Absorption	Level 3: Common	Across all sectors there was leased line connectivity, but below 90% except for higher education.
Connectivity Infrastructure	Level 3: Broad	Slow broadband uptake and the closing of South Africa's second Internet exchange were troubling.
Organisational Infrastructure	Level 3: Competitive	There was a healthy ISP industry, but a *de facto* monopoly on fixed line provision.
Sophistication of Use	Level 3: Transforming	South Africa successfully embraced the Internet. Liberalisation policies should help spur innovation.

Table 25. * Breakdown of Dimensions for 1994 to 2004

	1994 – 1996	1997 - 1999	2000 - 2002	2003 - 2004
Pervasiveness	2	2	3	3
Geographic Dispersion	2	3	3.5	3.5
Sectoral Absorption	2	2	3	3
Connectivity Infrastructure	1.5	2	3	3
Organisational Infrastructure	2	3	3	3
Sophistication of Use	1	2	3	3

* Numbers refer to GDI dimension levels.

The trend of stagnation is worrying for policy makers because in 1994 South Africa was one of the leading adopters of the Internet, but has seen its global rankings drop over time [Gillwald and Kane 2003; Goldstuck 2004a]. For instance, in terms of number of Internet users, its rank dropped from 13th in the world in 1996 to 26th in 2001 [Gillwald and Kane 2003]. This report will now discuss the various determinants that have affected Internet diffusion following which the effects of 2004 policy directives will be examined.

IV. DETERMINANTS OF INTERNET DIFFUSION IN SOUTH AFRICA

The GDI framework includes 12 determinants which may affect Internet diffusion [Wolcott et al. 2001]. These determinants are outlined in Appendix 1. In this section each of the determinants will be discussed in the context of South Africa.

PERCEIVED VALUE OF THE INTERNET

The importance of ICTs for national development is recognised at the very top by the South African President, Thabo Mbeki, who announced the formation of an international as well as a national Advisory Council on Information Society and Development in 2001 [CPSU 2003]. The value the government sees in the Internet is furthermore borne out by plans for the establishment

of e-government. In the business world, the use of the Internet in traditionally non-Internet environments is growing [CPSU 2003]. As Goldstuck [2002a] states, "The Internet underpins so much of our business lives today, it would be near impossible for the corporate world to function without it." (p. 4). On an individual user level, several studies show the Internet is used most often for communications (e.g., email), and for getting information [Brown 2003; De Villiers and Van Der Merwe 2001]. Use of this channel for shopping, banking, and financial transactions is more prevalent among higher-income workers and managers, typically within the first economy [Brown et al. 2004; Buys and Brown 2004]. Few studies have focused on the second economy. Among SMEs the Internet is predominantly used for email and banking [Goldstuck 2004a].

EASE OF USE

The GDI framework regards literacy rates, education, and access to local language content as good measures of the ease of use of the Internet at a national level [Wolcott et al. 2001]. Each of these will be discussed in turn.

Literacy

The literacy rate of South Africa as cited by the CIA [2004] is 86.4 percent. When compared with developed countries such as the USA where the literacy rate is 97 percent [CIA 2004], it may be seen as a factor that limits Internet usage.

Education

25.4 million people in South Africa are older than 20 of which 64 percent are educated to the primary level [StatsSA 2003]. Only a small portion of these are Internet users. The limited use of the Internet has more to do with its affordability and access rather than the level of education. Nevertheless, with the provision of Internet access, training, and support should also be provided simultaneously. Without training and support, the perceived complexity of Internet use may inhibit usage, especially among adults.

Local Language Content

Eleven official languages are spoken in South Africa with English recognised as the language of commerce and science [Stats SA 2003]. Students are often taught in English and most Web sites have English content. Only 8.2 percent of the population claim English as their first language [StatsSA 2003]. Access to local language content is therefore still important to encourage greater use of the Internet. The majority of South African Web sites are not multilingual, but the government is committed to promoting local language content. By way of example, an initiative of the Western Cape Province is to provide local language access for all of its Internet services [Mohapeloa 2003].

COST OF INTERNET ACCESS

Typical costs for dial-up connectivity would include a telephone line subscription, ISP subscription, and call charges, not to mention subscription for services such as Internet banking. Gillwald and Kane [2003] provide some interesting findings regarding the cost of Internet access in South Africa: Between 1996 and 2002, the average annual increase in local telephone charges was about 27 percent - far greater than inflation for the same period. Almost 90 percent of Internet subscribers' costs for 30 hours peak use per month were made up of Telkom charges [Gillwald and Kane 2003]. The total cost to an Internet subscriber for 30 hours of surfing during peak hours was estimated to represent about 33 percent of the average monthly income in South Africa [Gillwald and Kane 2003]. Given the high disparities of income between a few rich and majority poor, the number of Internet users per capita will not increase substantially until costs are drastically reduced. High telecommunications costs are undoubtedly a leading cause of South Africa's slow-down in Internet growth. Any further growth will have to be as a result of increased GDP and/or a drastic reduction in costs of Internet access. The rapid growth of cell phone usage has demonstrated that if a suitable pricing model is employed and there is an enabling

environment, broad-based technology diffusion among lower income earners can occur [Hodge 2005].

ACCESS TO CONSTITUENT TECHNOLOGIES

Telephone Access

South Africa has a teledensity of approximately 11.35 main lines per 100 – one of the highest in Africa, but low when compared with developed countries [ITU 2002]. This teledensity partially explains why the number of Internet users per capita has not risen above 1 in 10. Fixed line telephone connectivity experienced a decline from 2000 to 2002 [Gillwald and Kane 2003]. Reasons included non-payments (caused partly by high and increasing costs), as well as migration to cell phone technologies [Gillwald and Esselaar 2004].

The high growth in cell phone usage offers opportunities for Internet access via this channel. Upper income users (who are part of the first economy) tend to be the early adopters of data services such as the Internet from a cell phone. They most likely form part of the 3-million strong Internet community. The digital divide has not yet been bridged by cell phone technology.

Computer Access

Most Internet access is via PCs. There were estimated to be about 6 to 7 computers per 100 inhabitants in South Africa in the early 2000s [ITU 2002]. This explained why the number of Internet users per capita was also within the range of 6 to 7 per 100. The high cost of PCs relative to the average income of South Africans limits Internet diffusion.

Public Facilities

Given the high costs associated with Internet and PC use, the government is focusing on providing public facilities in disadvantaged areas and schools. Indeed, for e-government initiatives to be successful, the provision of access to all has to be addressed. Various government initiatives are therefore underway, such as the rollout of multi-purpose community centres (MPCCs), and Public Information Terminals (PITs) [The e-Business Handbook 2003]. These initiatives are aimed at both rural areas and the economically disadvantaged urban areas, which despite their proximity to the sophisticated infrastructure in city centres are in many cases without Internet facilities.

DEMAND FOR CAPACITY, MULTIPLICITY OF ISPS, SERVICES PROVIDED

Local demand for Internet services encourages the expansion of infrastructure and the creation of new services and service providers [Foster et al. 2004]. Demand for capacity and connectivity is concentrated around major cities. Table 20 showed that the number of ISPs grew from 7 in 1994 to 270 in 2003 [Goldstuck 2004a]. Leased line growth varied from 38 percent in 1995 to 71 percent in 1999 and back down to 20 percent in 2004 [Goldstuck 2004a]. Internet dial-up user growth slowed from 158 percent in 1995 to 6 percent in 2004 [Goldstuck 2004a]. Overall growth in Internet users slowed from 98 percent in 1995 to it lowest level of 4 percent in 2004 [World Wide Worx 2005a]. These factors indicate that a certain level of saturation may have been reached in what has been termed the developed first economy of South Africa. In the developing second economy, there is still huge potential for growth, but socio-economic conditions and costs are inhibitors.

GEOGRAPHY

Countries with rugged terrain face great difficulty in building ICT infrastructure [Foster et al. 2004]. South Africa consists of a “vast interior plateau rimmed by rugged hills and narrow coastal plains” [CIA 2004]. The dispersion of the population across the country in sometimes-remote locations does make provision of service to all a challenge [Gillwald and Kane 2003]. Analysis of service provision in non-urban areas shows that it is not so much the geographic terrain, but the socio-

economic conditions which are a hindrance. Gillwald [2002], for example, found that in non-urban areas 82 percent of White people (often historically advantaged) have telecommunications service as compared to 5 percent of Black people (often historically disadvantaged).

ADEQUACY AND FLUIDITY OF RESOURCES

The human and technical resources that have been used to establish the sophisticated, primarily urban ICT infrastructure are theoretically available also for development in disadvantaged urban and rural areas. There is often a lack of economic incentive for commercial ventures to invest in these areas [Licker and Motts 2000]. State-owned enterprises and many forward-looking commercial organisations have social responsibility programs in place. These programs are used to help bridge the digital divide by, for example, investing in computers and Internet access for schools. Government also provides incentives to ensure the disparities are addressed. In 2003, mobile network operators were granted access to a frequency band spectrum, and in return were required to distribute 4 million SIM cards and 250,000 free phones to disadvantaged individuals [The e-Business Handbook 2003]. The country's Black Economic Empowerment (BEE) strategy [DTI 2003] was well received by progressive organizations. The strategy should result in resources being made available for projects targeted at, among other things, bridging the digital divide.

ABILITY TO EXECUTE

The ability to execute projects influences the rate and extent of infrastructure growth within a country [Foster et al. 2004]. In South Africa, "e-commerce know-how, and 'delivery' expertise is largely retained in the private sector and acutely lacking in the public sector . . . expertise is tied up serving the top 250 or so corporations" [Licker and Motts 2000, p. 115]. This state of affairs coupled with the fact that there is already an ICT skills shortage across both the private and public sector, severely hampers the ability to execute, especially projects in the public sector. Nevertheless progress is being made, given the clear government policy on, for example, e-government and their commitment to implementation [The e-Business Handbook 2003].

CULTURE OF ENTREPRENEURSHIP

Concerning entrepreneurship and innovation at the corporate level, the retail banking industry perhaps leads the way. Absa bank managed to capture the largest market share in Internet banking, in part, through its launch of an initial free Internet access offering [The e-Business Handbook 2003]. The free offering has since evolved into a paid-for service. It is now one of the largest ISPs in South Africa despite this change [The e-Business Handbook 2003]. 20Twenty was launched as the first virtual bank having no brick and mortar presence and attracted a loyal customer base despite some hiccups [The e-Business Handbook 2003]. In the cellular network sector, growth of the cell phone market through prepaid facilities demonstrated entrepreneurship.

The most high profile example of individual entrepreneurship is that of Mark Shuttleworth, who founded an Internet consulting business (Thawte Consulting) while still at university in South Africa. The company focused on Internet security and was the largest certificate authority outside the USA when acquired by Verisign [First African in Space 2003]. Such entrepreneurship is being encouraged and motivated many Internet start-ups in South Africa.

FORCES FOR CHANGE

The drivers for change can come from many different areas in a country such as a competitive environment, individuals who encourage change or a cultural predisposition to change [Foster et al. 2004]. Culturally South Africans are used to change, with the end of apartheid and the formation of a fully democratic state having occurred just over a decade ago. Individuals such as Mike Lawrie and his fellow academics were great drivers of change and helped to build the Internet in South Africa [Goldstuck 2004a]. The championing of ICTs for national development comes from the South African president, who formed the International Advisory Council on

Information Society and Development, and the Presidential National Commission on Information Society and Development respectively [GCIS 2003]. South Africa is therefore in possession of not only a cultural predisposition to change but also great individuals that encourage change.

ENABLERS OF CHANGE

Among the advantaged primarily urban society, the Internet has been wholly embraced. This is perhaps not surprising given that this sector of society operates in an almost developed country environment. This is in contrast to the disadvantaged sectors of society, living primarily in high-density urban and rural areas where there is poverty, lack of resources, and lack of educational facilities. The drive to provide computers and Internet in disadvantaged schools will have positive educational benefits. By providing access also to the wider community it is hoped that social and economic benefits may accrue. The phenomenal diffusion of cell phones even among the disadvantaged communities is viewed as an opportunity for value-adding data services to also reach critical mass. Wireless infrastructure has added appeal for providing access in rural areas due to the absence of fixed line infrastructure in many areas and the relative ease with which such networks can be set up [Gillwald and Kane 2003]. GPRS (2.5G) is in place on all three mobile networks and Vodacom began testing its 3G WCDMA service in July 2004 [Cellular Online 2004]. As at 2004 the three networks covered more than 71 percent of the population [Cellular Online 2004]. This presents a significant enabler of change in the areas of mobile commerce and mobile Internet access.

REGULATORY/LEGAL FRAMEWORK

The Department of Communications is responsible for policy-making and review in the communications sector [GCIS 2003]. Broad policy directives are aimed at achieving a balance between maintaining and growing a sophisticated telecommunications infrastructure to increase global competitiveness, while developing the second economy, and empowering the previously disadvantaged [Gillwald and Kane 2003]. Initiatives that have an effect on the diffusion of the Internet include the following:

- The establishment of the Universal Service Agency (USA), to ensure telephone and advanced communication access such as the Internet to all [GCIS 2003]. Due to lack of skills and capacity, the introduction of telecentres by this agency in rural underserviced areas met with some problems [Gillwald and Kane 2003].
- The awarding of underserviced area licences (USALs) to consortiums from historically disadvantaged backgrounds for the provision of telecommunications in underserviced areas [e-business Handbook 2004; Gillwald and Kane 2003]. Significantly, the USA will give support to these operators [e-Business Handbook 2004].
- The official end to the Telkom monopoly in the fixed line network sector in May 2002. Delays in licensing the SNO meant that the monopoly was still in effect in 2004 to the detriment of greater competition, and greater Internet diffusion [Goldstuck 2002a].
- The electronic communications and transactions (ECT) act, which brought more certainty to the e-commerce landscape [GCIS 2003].
- The awarding to Sentech (previously a broadcast signal distributor for the state), carrier-of-carriers and multimedia licenses [e-Business Handbook 2004]. Sentech offers broadband wireless services, and digital satellite broadcasting services [Goldstuck 2004a].
- There was debate on a convergence bill in recognition that “digital transmission technology will lead to the emergence of an integrated infrastructure capable of delivering voice, video, and data services at high speeds and lower costs” [Gillwald and Kane 2003, p. 9].

SUMMARY

In summary, Internet diffusion has been positively influenced by its perceived value to business (both large and small), government, nongovernmental organisations and society in general.

Literacy rates are relatively high, and English is the language of commerce and science in South Africa. This aligns well with the use of the Internet, since most Web sites are in English. A healthy ISP industry has built up over the period 1994 to 2004 despite the existence of a telecommunications monopoly in the fixed line telecommunications sector. The burgeoning cell phone market offers opportunities for further diffusion. As the cell phone market matures it will begin to provide an alternative channel through which South Africans may access the Internet.

Factors hindering Internet diffusion include the lack of local language content, which is especially important considering there are 11 official languages. High costs associated with Internet access are perhaps the major hindrance given the socio-economic conditions that prevail [Gillwald and Kane 2003]. Similarly, access to constituent technologies such as fixed telephone lines and PCs also present as impediments because of their high costs. South Africa is plagued by a skills shortage which ultimately affects the ability to execute projects. Finally, the regulatory environment sometimes acts as an inhibitor to diffusion. The licensing of the SNO, for example, was not implemented expeditiously leading to lost opportunities for growth [Gillwald and Kane 2003].

V. RECOMMENDATIONS: GOVERNMENT POLICY AND THE DETERMINANTS OF INTERNET DIFFUSION

Table 26 highlights ways in which government can impact the determinants to promote Internet diffusion, in addition to or as part of current initiatives.

South African Internet diffusion stagnated along all dimensions between 2000 and 2004 (see the Kiviat diagram in Figure 2). From the analysis we have identified South Africa's regulatory/legal framework, *de facto* telecommunications monopoly, delayed implementation of policies, and the socio-economic gap between the first and second economies as the core reasons for the sluggish growth. Policy directives announced after the bulk of the above analysis was completed, seem to have addressed many of these concerns, and so will be reported next.

VI. 2004 POLICY DIRECTIVES

Given that the previous sections relied on data prior to 2005, there is need to capture the implications of policy directives by the government of South Africa targeting the year 2005 and beyond. The document that was selected for analysis was a policy statement by the Minister for Communications, Dr. Ivy Matsepe-Casaburri on the 2nd of September, 2004 [Balancing Act 2005]. Statements reported in other publications were also analysed [e.g., e-Business Handbook 2004].

The first policy directive (P1) removes the restriction that required mobile operators to source their fixed line requirements from Telkom. Since the Internet may also be provided by mobile operators, there could be a potential impact on Internet diffusion. More specifically, there could be positive impacts on at least two of the GDI dimensions. The first is on the organizational infrastructure dimension where the provision of domestic infrastructure will now be open to greater competition (see Table 19). The other positive impact is that introducing competition will prompt the firms in the environment to be more innovative. Innovativeness will help improve the rating along the sophistication of use dimension.

The directive concerning provision of public payphones (P2) will impact positively on access to telephone services, and indirectly Internet services by encouraging entrepreneurship and innovation. This greater access may improve the level of pervasiveness and geographic dispersion as these services become more widely available, especially in disadvantaged rural communities.

Table 26: Policy Recommendations for South Africa

Determinant	How government can impact determinant
1. Perceived value	Continue to focus attention on ICT use in the second economy. Speed up implementation of e-Government services Implement recommendations of the Presidential International Advisory Council on ICTs.
2. Ease of use of the Internet	Encourage more local language content. Intensify programs aimed at increasing adult literacy. Establish training centres to provide people with ICT skills.
3. Cost of Internet access	Encourage competition to lower telephone costs. Facilitate in removing impediments delaying the SNO operations
4. Access to constituent technologies	Promote innovative means of growing Internet access in rural areas Lower costs of ICTs through incentives or subsidies.
5. Demand for capacity, multiplicity of ISPs, services provided	Lower costs through promoting competition. Encourage mobile and wireless access to the Internet
6. Geography	Encourage infrastructure development in under serviced areas.
7. Adequacy and fluidity of resources	Incentivise projects in under-served areas. Encourage ICT skills training and transfer
8. Ability to execute	Lower barriers to immigration of skilled labour.
9. Culture of entrepreneurship	Encourage entrepreneurship and job creation in the second economy, especially in the ICT sector.
10. Regulatory/legal framework	Liberalise the telecommunications market, and allow for greater competition. Allow ISPs to provide VoIP and other telecommunications services.
11. Forces for change	Encourage competition in the telecommunications market.
12. Enablers of change	Encourage mobile phone market. Increase the level of ICT education and access in schools

Policy directive P3 focuses on allowing VANs to provide voice services (e.g. VoIP), previously the domain of Telkom and the SNO once operational. This will promote Internet usage as firms opt for this cheaper mode of voice communication. Pervasiveness and sectoral absorption will be positively influenced. Internet cafes and other such entities will also be able to offer this additional voice service, encouraging competition, entrepreneurship, and ultimately reducing costs to the consumer.

Directive P4 allows VANs to source for telecommunication services from any provider. The impact of this policy would be to further enhance competition with its attendant benefits. There will be noticeable innovation amongst the VANs and other providers in their technology deployments. Improvements are hence expected in the dimensions of organisational and connectivity

infrastructures since this policy will break the dependence of VANs on Telkom. The sophistication of use dimension will also improve as a result.

Table 27. 2004 Policy Statements [as reported in Balancing Act, 2005]

Government Directives
P1. Self-provision and Greater Choice for Mobile Operators: "*As of 1 February 2005 Mobile operators may utilise any fixed lines that may be required for the provision of the service including fixed lines made available by Telkom or any other person providing a public switched telecommunication service*".
P2. Provision of Public Pay Phones: "*As of 1 February 2005 persons may apply for a licence to provide public pay phone services in any area of the Republic*".
P3. Provision of Voice by Value Added Service Providers: "*As of 1 February 2005 value added network services may carry voice using any protocol*".
P4. Choice in the Provision of Value Added Network Services: "*As of 1 February 2005 value added network services may also be provided by means of telecommunications facilities other than those provided by Telkom and the Second National Operator*".
P5. Cession of Telecommunications Services by VANS: "*1 February 2005 shall be the date from when a person who provides a value added network service shall be entitled to cede or assign the right to use, or to sublet or part with control or otherwise dispose of the telecommunications facilities used for the provision of the value added network service*".
P6. Optimising the Use of Private Telecommunications Network Facilities: *"As of 1 February 2005 private telecommunications network operators shall be entitled to resell spare capacity and facilities or to cede or assign his or her rights to use such facilities or to sublet or otherwise part with control thereof*".
P7. Preparing our Youth for the Knowledge Economy: "*As of 18 January 2005 public schools and public further education training institutions will be entitled to a 50% discount on: * all telecommunications calls to an Internet service provider * any connection or similar fees or charges levied by an Internet service provider for accessing the Internet or transmitting and receiving any signals via the internet or for such access and transmission and reception*"

The VANS have also been allowed to cede their telecommunications services (P5) whilst private telecommunications network operators have been allowed to optimize the use of their telecommunications network facilities (P6). This will have a positive impact on connectivity infrastructure by, for example, increasing the available domestic bandwidth. It may also have a positive impact on the organisational infrastructure by introducing competition in the provision of network infrastructure.

The last policy directive (P7) is aimed at preparing the youth for the knowledge economy by focusing on improving the diffusion of the Internet in public schools and further education training institutions. The reduced cost of access will have a positive impact on sectoral absorption - the education sector specifically.

In the light of this analysis, the recommendations suggested earlier in Table 26, some of which have in fact been addressed by the 2004 policy directives, are now reexamined. Those recommendations that have been addressed are italicised in Table 28 below.

Table 28: Impact of 2004 Policy Directives on Determinants

Determinant	How government can impact determinant	How new policy impacts
1. Perceived value	*Continue to focus attention on ICT growth in the second economy*. Speed up implementation of e-Government services *Implement recommendations of the Presidential International Advisory Council on ICTs*.	*Directives P2 and P7 will facilitate this.* *The policy directives have been hailed by the advisory committee (Business Day, 2004a).*
2. Ease of use of the Internet	Encourage more local language content. Intensify programs aimed at increasing adult literacy. *Establish training centres to provide people with ICT skills*.	*Directive P7 may encourage more ICT skills training*
3. Cost of Internet access	*Encourage competition to lower telecommunications costs*. Facilitate in removing impediments delaying the SNO operations	*All policy directives in some way impact on the costs of telecommunications.*
4. Access to constituent technologies	*Promote innovative means of growing Internet access in rural areas* *Lower ICT costs through incentives or subsidies*.	*Policy directives P2 and P3 have the potential to do so.* *Policy directive P7 allows for a 50% discount on costs for public educational institutions.*
5. Demand for capacity, multiplicity of ISPs, services provided	*Lower costs through promoting competition.* *Encourage mobile and wireless access to the Internet*	*Directives P1 to P6 encourage competition.* *Directive P1 may encourage innovation in the provision of mobile access*.
6. Geography	*Encourage infrastructure development in under serviced areas*.	*Directive P2 may encourage this.*
7. Adequacy and fluidity of resources	Incentivise projects in under-served areas. *Encourage ICT skills training and transfer*	*Reduced costs for public education institutions may result in greater levels of ICT skills training (Directive P7)*

Determinant	How government can impact determinant	How new policy impacts
8. Ability to execute	Lower barriers to immigration of skilled labour	
9. Culture of entrepreneurship	*Encourage entrepreneurship and job creation in the second economy, especially in the ICT sector*.	*Directive P2 specifically and P3 to P6 encourage entrepreneurship*
10. Regulatory/legal framework	*Liberalise the telecommunications market, and allow for greater competition.* *Allow ISPs to provide VoIP and other telecommunications services*.	*Directives P1 to P6 address this recommendation* *Directives P3 and P5 address this concern*
11. Forces for change	*Encourage competition in the telecommunications market*.	*Directives P1 to P6 address this recommendation*
12. Enablers of change	*Encourage mobile phone market.* *Increase the general level of education and ICT access in schools*	*Directive P1 addresses this recommendation.* *Directive P7 addresses ICT access in education*

VII. INTERNET DIFFUSION IN SOUTH AFRICA BEYOND 2004 (2005 - 2006)

The previous sections have focused on Internet diffusion in South Africa over the first decade of democracy (1994 to 2004) and the impact of 2004 policy directives. For the sake of completion and currency, Internet diffusion trends over the most recent period (2005 to 2006) will be briefly reviewed. To conduct this review, the GDI framework will once more be employed. The dimensions of pervasiveness, geographic dispersion, sectoral absorption, connectivity infrastructure, organisational infrastructure and sophistication of use will each be discussed in turn.

PERVASIVENESS

After slowing to 4 percent in 2004, growth rose to 5 percent in 2005 [World Wide Worx 2005a]. The slightly higher growth was attributed in part to the decreased price of broadband ADSL [Paul Budde Communication 2006]. In 2005, for the first time since 1993, there was no growth in dial-up subscriptions [World Wide Worx 2005a]. By early 2006 the number of Internet users per capita was about 8 percent [World Wide Worx 2005a], still below the 10 percent threshold required for level 4 rating.

GEOGRAPHIC DISPERSION

A lack of commonly available rural access prevented a rating of level 4 for geographic dispersion in 2004. From 2005 to 2006 programs to increase access in underserved rural and urban areas continued as new multi-purpose community centres (MPCCs) were rolled out [GCIS 2005]. The first set of underserviced areas licences (USALs) were granted to SMEs in 2004 [Gillwald and Esselaar 2004]. The licences allow these SMEs to provide telecommunications services in underserviced areas. Rural access by 2006 was not yet common, and the rating for geographic dispersion remained at level 3.5.

SECTORAL ABSORPTION

In the education sector, the expected reduced cost of access for schools as a result of the policy directive P7 (see Table 27) did not immediately materialise. Several schools complained that they were not receiving the 50 percent discount, and were not able to backdate it to 18 January 2005, the effective date of the policy directive [Vecchiatto 2005]. Government programs to increase access at schools were expected to provide much of the impetus for growth beyond 2004, but did not live up to expectation due to delayed implementation [World Wide Worx 2005a].

In the commercial sector, following the deregulation of VOIP on 1 February, 2005, there was an increase in demand for leased lines [World Wide Worx 2005a]. Much of the demand came from organizations wishing to increase their existing bandwidth to accommodate VOIP [World Wide Worx 2005a]. Deregulation of VOIP also had a direct impact on the creation of new businesses such as in the call centre industry. The deregulation helped increase the competitiveness of South Africa in this domain [Business Day 2004b].

The government's 10-year e-government implementation plan continued, albeit at a slower rate than envisioned [Effective e-Government 2006]. By 2004, phase 1 (provision of information) was well underway, and phase 2 (allowance for two-way transactions) implementation was apparent, for example, within the South African Revenue Service (SARS). By 2006, there was also evidence of phase 3 (multi-purpose portals) implementation [Effective e-Government 2006]. Phase 4 (personalised portals per citizen) had yet to be widely implemented. Phase 5 is concerned with clustering government e-services. By 2005, national government was delivering services in clusters, thereby aligning with the goals of phase 5 [Effective e-Government 2006]. Phase 6 (comprehensive transformation) is the ultimate phase.

CONNECTIVITY INFRASTRUCTURE

International links

In 2006, South Africa was one of three African countries with more than 1 Gbps of international bandwidth [Paul Budde Communication 2006]. Much of the capacity is provided through the SAT-3/WASC/SAFE submarine cable system. Telkom is a key stakeholder in the consortium responsible for the cable system [SAT-3/WASC/SAFE 2004]. The system comprises two cables. The SAT-3/WASC cable runs around the Atlantic coast of Africa to Europe, and has a potential capacity of 120 Gbps [SAT-3/WASC/SAFE 2004]. The SAFE cable runs across the Indian Ocean to Asia and has a potential capacity of 130 Gbps [SAT-3/WASC/SAFE 2004]. Telkom is estimated to have rights to about 20 percent of this capacity [Anderson 2005]. The high costs charged by Telkom for access to this bandwidth have come under scrutiny, as they impact on the provision of affordable broadband [Anderson 2005; Business Day 2006b].

The South African government announced in 2006 the formation of a new state owned entity called Infraco with the aim of reducing the cost of broadband [Business Day 2006a; Weidemann 2006]. Details about this new venture are still to be clarified [Business Day 2006a]. It will reportedly be involved in laying a new submarine cable to compete with the SAT-3/WASC cable [McLeod 2006b; Weidemann 2006].

Domestic Backbone

The liberalisation of the telecommunications sector has had a marked effect on the domestic backbone infrastructure formerly controlled by Telkom. Infraco, the new state-owned broadband entity is reported to have as its key asset a national fibre optic network [Business Day 2006a]. Sentech (a state-owned broadcast and wireless provider) has plans to set up a national broadband wireless network [McLeod 2006b].

Access Methods

The period 2005 to 2006 saw an increased focus on broadband as an alternative access method. In early 2005, the number of ADSL users was estimated to be about 50,000 [Christian 2005]. Toward the end of 2005, this figure had grown to about 120,000 [Christian 2005]. Telkom reported about 190,000 ADSL subscribers by 2006, with an estimated installation rate of about 7,900 lines per month [MyADSL 2006a]. This growth was attributed in part to cost reductions [Paul Budde Communication 2006]. Despite these reductions, ADSL costs in South Africa remained among the highest in the world [Anderson 2005]. The affordability constraint hampered widespread diffusion, with a large proportion of new adopters being those moving from slower dial-up access to ADSL [Christian 2005; World Wide Worx 2005a]. The digital divide thus persisted [World Wide Worx 2005c].

The high costs of ADSL broadband offered an opportunity for wireless providers to provide a viable alternative using technologies such as 3G and HSDPA. By 2006, there were estimated to be about 225,000 wireless broadband users [MyADSL 2006b]. Market share was reportedly divided among four key providers – Vodacom (49 percent), MTN (38 percent), iBurst (11 percent) and Sentech (2 percent) [MyADSL 2006b].

ORGANISATIONAL INFRASTRUCTURE

Competitiveness in the Market

2005 saw the long-awaited granting of a license to the SNO [Fin24 2005]. The official launch of the SNO, named NeoTel, took place in 2006 [Weidemann 2006]. The majority shareholder in the SNO is Indian group Tata [Weidemann 2006]. NeoTel is expected to begin full scale operations in 2007.

In a separate development, a few municipalities began to roll out wireless broadband services using existing electricity power lines, Wi-Fi and WiMax technologies [Business Day 2006b]. These initiatives further enhanced competition in the telecommunication sector. Third-party service providers intend to make use of the municipality infrastructure [McLeod 2006b]. Goal Technology Solutions (GTS), for example, plans to provide triple-play (broadband Internet access, subscription television, and Internet telephony) through the use of the municipal electricity infrastructure [McLeod 2006b; MyADSL 2006c].

It was announced that mobile operators would be allowed to self-provide on international links [Weidemann 2006]. This was in line with the 2004 policy directive P1 (see Table 27), which stated that mobile operators be allowed to utilize any fixed lines in the provision of service.

The Electronic Communications act was promulgated in 2006, replacing the Telecommunications act of 1996. The act is supportive of liberalization and competition in the sector, and is worded so as to avoid formation of monopolies or entities with exclusive rights [McLeod 2006b]. A shortage of skills and capacity in the regulatory body ICASA is cause for concern, as this body, according to the act, must play a major role in regulating the industry [McLeod 2006b].

ISP Industry

By 2006 there were 12 majors ISPs holding 90 percent of the market share, and about 200 smaller operators [Paul Budde Communication 2006]. ISPs have been more aptly described as converged service providers, given that they now provide VOIP, broadband, and other web services [Paul Budde Communication 2006]. In 2007, Telkom and top-tier ISPs such as Internet Solutions (IS) and Verizon Business intend to offer telecommunications services using WiMax [McLeod 2006b].

SOPHISTICATION OF USE

Online retail sales revenue continued to grow robustly. The largest growth was in the sale of air tickets online, where revenue amounted to three times that of conventional online retail in 2005 [World Wide Worx 2006a].

As GPRS and 3G-enabled cell phones diffused more widely, Internet access over these devices, and usage of services such as cell phone banking increased. In 2005, it was estimated that about 10 percent of bank account holders had used cell phone banking [World Wide Worx 2006b].

The period 2005 to 2006 was characterized by increased government spending on infrastructure. Several infrastructure projects are related to the 2010 soccer World Cup to be hosted by South Africa. Digital terrestrial television, for example, is to be rolled out in time for this event [McLeod 2006a]. There are more households with TVs than computers in South Africa [StatsSA 2003]. Digital terrestrial broadcasting could therefore be used to widen the reach of converged digital service offerings (e.g., Internet-based services) through the medium of TV. In addition, broadband TV and triple-play technologies are being piloted using alternative technologies [MyADSL 2006c; Paul Budde Communication 2006]. Several organizations have applied for pay TV licences to compete directly with DStv, which as at 2006 was the only digital pay TV service in South Africa [Mametse 2006]. DStv makes use of satellite broadcast technology, while the new operators will be employing a variety of other technologies. Mobile TV is set to be launched in 2007 [Whitford 2007]. It is touted as being the next killer application, due to the combination of TV and the interactivity inherent to cell phone use [Whitford 2007].

SUMMARY

In summary, the policy directives announced at the end of 2004 have to a large extent had the desired effect of increasing competition and innovation in the telecommunications industry. Liberalisation has been supported by the new electronic communications act. Due to persistent high costs for services, pervasiveness of the Internet has not yet increased significantly. Many new broadband users are existing Internet users migrating from slower dial-up access. The SNO was finally licensed in 2005 and is to begin full-scale operations in 2007. Municipalities also began rolling out facilities for broadband access. The increased competition with Telkom may finally result in cost reduction and wider Internet access. Government has turned their attention to the provision of affordable broadband access through the establishment of a new state owned entity called Infraco. The hosting of the 2010 soccer World Cup in South Africa has increased the pace of infrastructure spend and spurred innovation in the realm of converged voice, video and data services. 2007 is set to be an exciting year for the converging telecommunications and broadcasting industry.

VIII. CONCLUSION

The Internet first became publicly available to South Africans in 1994 [Goldstuck 2002a]. This coincided with the inauguration of the first democratically elected government [Goldstuck 2004c], and the launch of cell phone services to the public [Telkom 2006]. This confluence of events has made the examination of Internet diffusion in the decade 1994 to 2004 a significant endeavour. Our analysis has shown that by 2004 up to 1 in 13 South Africans were making use of the Internet, with PoPs in every province of the country. The Internet had been embraced by all sectors, with absorption common in education, health, government, and commercial sectors respectively. The connectivity infrastructure was broad, and the organisational infrastructure competitive. The level of sophistication of use was at the transforming level.

Despite this generally positive picture, the analysis showed that growth was sluggish between 2000 and 2004. The reasons for this slowdown were complex and interrelated. The *de facto* telecommunications monopoly in the fixed line sector kept costs high. Legislation to allow for a second national operator (SNO) to provide competition (and thus reduce costs) was promulgated in 2002, but as at the end of 2004 this SNO had not as yet begun operations. Stifling regulation

that, for example, made it illegal for operators other than the telecommunications monopoly to provide VoIP services impeded growth. The wide socio-economic divide between the first and second economy was another inhibiting factor. Much of the growth took place within the first economy, which reached a level of diffusion similar to some developed countries. In the second economy on the other hand, diffusion was slow, with the status being similar to that in many developing countries. In contrast, there was phenomenal uptake of cell phones across both sectors. Recommendations to improve the situation (Table 26) were primarily around addressing these key challenges.

Policy directives announced at the end of 2004 were welcomed by a variety of stakeholders, and they went some way in addressing the recommendations for policy intervention in Table 26. As a result of these directives, the perceived value of the Internet increased. The liberalisation of the telecommunications market contributed to the introduction of new and innovative products and services and spurred demand and entrepreneurship. Despite this, the costs of telecommunications remained high. Internet access costs for public schools and further education training institutions received some respite through a 50 percent discount. The ability to execute new projects and to regulate the industry was still hampered by a skills shortage and lack of capacity. The policy directives also did not address the wider socio-economic conditions that inhibit diffusion, nor more specific recommendations such as those suggested for influencing the ease of use determinant.

While the policy directives have had a major impact, it will not be the use of these policies alone, but rather their incorporation into the wider socio-economic and political framework accompanied by rapid implementation that will encourage even greater Internet diffusion. The correct use of incorporated policies has been demonstrated in Estonia and Slovenia where Internet diffusion is among the highest in Central and Eastern Europe [Kitsing 2004].

Future research can build on this study by examining in more detail the consequences of the 2004 policy directives to establish the extent of their effect. Diffusion in the first and second economy can also be compared longitudinally. Finally GDI studies can be conducted in neighbouring Southern African countries to assess whether they have followed the same trends. Given South Africa's dominance in the region, the impact of the policy directives on neighbouring countries can also be investigated.

IX. ACKNOWLEDGEMENTS

We would like to acknowledge the advice and guidance of Will Foster in the initial preparation of this article.

X. REFERENCES

EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers, who have the ability to access the Web directly from their computer or are reading the paper on the Web, can gain direct access to these references. Readers are warned, however, that

1. these links existed as of the date of publication but are not guaranteed to be working thereafter.

2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.

3. the authors of the Web pages, not CAIS, are responsible for the accuracy of their content.

4. the author of this article, not CAIS, is responsible for the accuracy of the URL and version information.

AISI: African Information Society Initiative. (2000). "AISI Connect National ICT Profile, South Africa (ZA)", AISI Connect Online Database, http://www2.sn.apc.org/africa/countdet.CFM?countries__ISO_Code=ZA. (Current Aug. 4, 2002).

ANC Today. (2001). "Apartheid's Legacy I: Racial Inequality Deeply Embedded in South Africa", *ANC Today*, 1(30), http://www.anc.org.za/ancdocs/anctoday/2001/at30.htm#art1, (Current Dec. 20, 2005).

Anderson, B. (2005). "Bandwidth Prices Exorbitant", *MoneyWeb*. Apr 20. http://www.mybroadband.co.za/nephp/?m=show&id=253. (Current Jan 8, 2007).

Balancing Act. (2004). "African Internet Developments", *Balancing Act* .148, http://www.balancingact-africa.com/news/back/balancing-act_148.html (Current Sep. 5, 2004).

Balancing Act. (2005). "South Africa's Department of Communications Undergoes a Competitive Mind-Shift But . . .", *Balancing Act.* 223, http://www.balancingact-africa.com/news/back/balancing-act_223.html (Current Dec. 19, 2005).

Brown, I. (2003). "The Role of Cognitive Instrumental Processes, Social Influence Processes and Perceived Behavioural Control in the Acceptance of the Internet as a Learning Tool", *Alternation - Special Issue on Cognitive Science.* 10(2), pp. 89 – 121.

Brown, I., Z. Cajee, D. Davies, and S. Stroebel. (2003). "Cell Phone Banking: Predictors of Adoption in South Africa - An Exploratory Study", *International Journal of Information Management*. 23, pp. 381 - 394.

Brown, I., R. Hoppe, P. Mugera, P. Newman, and A. Stander. (2004). "The Impact of National Environment on the Adoption of Internet Banking - Comparing South Africa and Singapore", *Journal of Global Information Management*. 12(2), pp. 1 – 26.

Brown, I. and P. Licker. (2003). "Exploring Differences in Internet Adoption and Usage between Historically Advantaged and Disadvantaged Groups in South Africa", *Journal of Global Information Technology Management*. 6(4), pp. 6 – 26.

Business Day. (2003). "Small Companies Still Prefer the Basic Modem", *Business Day*. Jun. 17.

Business Day. (2004a). "Mbeki's Telecom's Advisers Welcome Sector's Shake-up", *Business Day.,* Sep. 6.

Business Day. (2004b). "New Jobs as Telkom Voice Monopoly Ends", *Business Day*. Sep 10.

Business Day. (2006a). "Erwin Comes to the Rescue on the Broadband Wagon", Technology @ Work, *Business Day*. Nov 2, http://www.businessday.co.za/articles/technology.aspx?ID=BD4A308240 (Current Jan 10, 2007).

Business Day. (2006b). "End Predicted for 'Telecoms Rip-off'", Technology @ Work, *Business Day*. Dec 14, http://www.businessday.co.za/articles/technology.aspx?ID=BD4A341699 (Current 10 Jan, 2007).

Buys, M. and I. Brown. (2004). "Customer Satisfaction with Internet Banking Web Sites: An Empirical Test and Validation of a Measuring Instrument", *Proceedings of the SAICSIT 2004 South African Institute of Computer Scientists and Information Technologists Conference*. Stellenbosch, South Africa, Oct. 4 – 6, pp. 44 - 52.

Cellular Online. (2004). "Statistics of Cell in South Africa", *Cellular Online*. http://www.cellular.co.za/stats/statistics_south_africa.htm, (Current Sep. 5, 2004).

Christian, C. (2005). "South Africa's ADSL at 120 000 Users", *MyADSL*. Dec 15, http://www.mybroadband.co.za/nephp/?m=show&id=1466 (Current Jan 9, 2007).

CIA: Central Intelligence Agency. (2004). "The World Fact Book 2004", CIA. http://www.odci.gov/cia/publications/factbook/. (Current Sep. 5, 2004).

CPSU: Commonwealth Policy Studies Unit. (2003). "Fostering Competitiveness in the Commonwealth through Electronic Commerce: Experiences and Policies Adopted in Four Commonwealth Countries" (March, 2003) http://www.cpsu.org.uk/downloads/Fostering.pdf. (Current Jul. 9, 2003).

De Villiers, C. and J. Van Der Merwe. (2001). "An Investigation into the Adoption of Electronic Commerce by South African Consumers– Who They Are and What They Think", Research Report. University of Pretoria, http://informatics.up.ac.za/tuksjvdm1.doc. (Current Aug. 5, 2002).

DPSA: Department of Public Services and Administration. (2001). "E-Government Policy", Second Draft, Version 4.13, DPSA, http://www.gov.za/documents/index.html. (Current Jul. 1, 2003).

DTI: Department of Trade & Industry South Africa. (2003). "A Strategy for Broad-based Economic Empowerment", DTI. South Africa.

e-Business Handbook. (2003). *The e-Business Handbook. The 2003 Review of Innovation at Work in South African Business*. Cape Town: Trialogue.

e-Business Handbook. (2004). *The e-Business Handbook. The 2004 Review of Innovation at Work in South African Business*. Cape Town: Trialogue.

Effective e-Government. (2006). *Effective e-Government*. Cape Town: ITWeb Informatica.

First African in Space. (2003). "Mark Shuttleworth: First African in Space", http://www.africaninspace.com. (Current Oct. 23, 2003).

Fin24. (2005). "Telkom Rival Has Arrived", *Fin24*, Dec 9 http://www.fin24.co.za/articles/default/display_article.aspx?Nav=ns&ArticleID=1518-24_1848251 (Current Jan 9, 2007).

Foster, W., S. Goodman, E. Osiakwan, and A. Bernstein. (2004). "Global Diffusion of the Internet IV: The Internet in Ghana", *Communications of the Association for Information Systems.* 13 (38), pp. 654 – 681.

GCIS: Government Communication and Information System. (2003). *South Africa Yearbook 2002/03*. GCIS, Pretoria: STE Publishers.

GCIS: Government Communication and Information System. (2005). "MPCC Initiative – Successes", GCIS http://www.gcis.gov.za/mpcc/initiative/success.htm. (Current Dec. 3, 2006).

Gilfillan, H and R. Schick. (1999). "The South African Internet Infrastructure: A Study of the Topology, Technologies, and Trends", Research Report. University of Cape Town, Graduate School of Business.

Gillwald, A. (2002). "Case Study: Broadband, the Case of South Africa", *ITU Regulatory Implications of Broadband Workshop*. May 2 – 4, 2001, Geneva.

Gillwald A. and S. Kane. (2003). "South African Telecommunications Sector Performance Review", Research ICT Africa. University of the Witwatersrand, http://link.wits.ac.za/papers/tspr2003.pdf. (Current Jun. 23, 2004).

Gillwald, A. and S. Esselaar. (2004). "South African ICT Sector Performance Review", LINK Centre Public Policy Research Paper No 7. Graduate School of Public and Development Management, University of the Witwatersrand.

Goldstuck, A. (2001). "South Africa - How Many Use Web Sites and Who Are They?" *Balancing Act News Update.* 71, http://www.balancingact-africa.com/news/back/balancing-act_71.html. (Current Jan. 18, 2002).

Goldstuck, A. (2002a). *The Goldstuck Report: Internet Access in South Africa., 2002.* Pinegowrie: World Wide Worx.

Goldstuck, A. (2002b). *The Goldstuck Report: Online Retail in South Africa., 2002.* Pinegowrie: World Wide Worx.

Goldstuck, A, (2004a). *The Goldstuck Report: Internet Access in South Africa 2004*. Pinegowrie: World Wide Worx.

Goldstuck, A, (2004b). *The Goldstuck Report: Online Retail in South Africa., 2004*, Pinegowrie: World Wide Worx.

Goldstuck, A, (2004c). "Insight: The Next Big Boom", *The Big Change – From Start-up to End-Game.* 4(1), May 21.

Hodge, J. (2005). "Tariff Structures and Access Substitution of Mobile Cellular for Fixed Line in South Africa", *Telecommunications Policy*. 29, pp. 493 – 505.

GovZA: South African Government Online. (2003). "About SA", http://www.gov.za/sa_overview/index.html. (Current Oct. 15, 2003).

ISPA: Internet Service Providers Association. (2005). "About ISPA", ISPA. http://www.ispa.org.za. (Current Jul. 5, 2005).

ISPMAP. (2004). "Welcome to the South African ISP Map", http://www.ispmap.org.za/, (Current Dec. 19, 2005).

ITU: International Telecommunications Union. (2002). "ICT – Free Statistics", ITU, http://www.itu.int/ITU-D/ict/statistics/. (Current Aug. 1, 2002).

James, T., P. Esselaar, A. Bowmaker-Falconer, Y. Quansah, C. Sibthorpe, J. Mosebi, and T. Mokoena. (2000). "A Survey of the IT Industry and Related Jobs and Skills in South Africa", *South African IT Industry Strategy (SAITIS) Baseline Studies.* http://www.dti.gov.za/saitis/studies/jobs_skills/index.html. (Current Aug. 5, 2002).

Jensen, M. (2002). "The African Internet – A Status Report", http://www3.sn.apc.org/africa/afstat.htm. (Current Jul. 2, 2003).

Kitsing, M. (2004). "The Impact of Economic Openness on Internet Diffusion in Estonia and Slovenia", Masters Thesis, The Fletcher School, Tufts University, http://www.fletcher.tufts.edu/research/2004/Kitsing-Meelis.pdf (Current Sep., 2004.

Lawrie, M. (1997). "The History of the Internet in South Africa: How it Began", http://apies.frd.ac.za/uninet/history. (Current Jul. 6, 2003).

Lewis, C. (2002). "South Africa-Internet Timeline 1990 – 2002", Center for International Development and Conflict Management, University of Maryland, http://www.cidcm.umd.edu/ntn/south_africa/time_lines.htm, (Current Sep. 5, 2004).

Lewis, C. (2004). "Negotiating the Net: The Case of South Africa", Center for International Development and Conflict Management, University of Maryland, http://www.cidcm.umd.edu/ntn, (Current Jul. 11, 2005).

Licker, P. and N. Motts. (2000). "Extending the Benefits of e-Commerce in Africa: Exploratory Phase", *Proceedings of the First Annual Global Information Technology Management World Conference***.** Memphis, Jun 11 -13, pp. 115-118.

Louw, J and L. Hanmer. (2002). "ICT Diffusion and ICT Applications in Use in Sector 'Health' (Draft Report), Implications of the Information Revolution for Economic Development in South Africa Study – Phase II", Medical Research Council, Cape Town.

Mametse. D. (2006). "Who's Offering the Best Deal in PayTV?", *MoneyWeb*. Dec, 21, http://www.mybroadband.co.za/nephp/?m=show&id=5241 (Current Jan 5, 2007).

McLeod, D. (2006a). "Digital Goes the Aerial Route", *Financial Mail*. Jan 20, http://www.mybroadband.co.za/nephp/?m=show&id=1722 (Current Mar 17, 2006).

McLeod, D. (2006b). "Switchboard Lights Up", *Financial Mail*. Dec 11, http://www.mybroadband.co.za/nephp/?m=show&id=5121 (Current Jan 10, 2007).

Mohapeloa, V. (2003). "Western Cape Embraces Multilingualism", *BuaNews.*

Molla, A. (2002). "e-Readiness and e-Commerce Success: Developing and Exploring an Antecedent Model in Developing Countries Context", Unpublished PhD Thesis, University of Cape Town.

MyADSL. (2006a). "Telkom's ADSL Numbers Don't Add Up", *MyBroadband*. Dec 6, http://www.mybroadband.co.za/nephp/?m=show&id=5083. (Current Jan 9, 2007).

MyADSL. (2006b). "The 'Real' Wireless Broadband Subscriber Base", *MyBroadband*. Dec 4, http://www.mybroadband.co.za/nephp/?m=show&id=5053 (Current Jan 9, 2007).

MyADSL. (2006c). "GTS: '90 Mbps Broadband Triple Play Service in SA in 2007'", *MyBroadband*. Dec 11. http://www.mybroadband.co.za/nephp/?m=show&id=5125 (Current Jan 9, 2007).

Pastore, M. (2000). "South Africa Nears 2 Million Internet Users", http://cyberatlas.internet.com/big_picture/geographics/article/0,,5911_380361,00.html. (Current Jul. 10, 2003).

Paul Budde Communication. (2006). "Executive Summary: 2006 African Broadband and Internet Market", Paul Budde Communication, Pty Ltd. http://www.biz-lib.com/ZPB91359.html (Current Jun 21, 2006).

Riordon, S. (2001). "SchoolNet South Africa: Accessing a World of Learning", International Development Research Centre (IDRC) Reports, Science from the Developing World**,** http://www.idrc.ca/reports/read_article_english.cfm?article_num=853, (Current Aug. 4, 2002).

SAT-3/WASC/SAFE. (2004). "SAT-3/WASC/SAFE", http://www.safe-sat3.co.za/HomePage/SAT3_WASC_SAFE_Home.asp (Current Jan 8, 2007).

SARPN: South African Regional Poverty Network. (2004). "Readings on the Second Economy", http://www.sarpn.org.za/documents/d0000830/index.php, (Current Dec. 19, 2005).

Sentech. (2004). "Sentech Speaks Out", *ICT World News Letter*. 98 http://www.ictworld.co.za/EditorialEdit.asp?EditorialID=19190&Archive=1 (Current Aug. 29, 2004).

Stats SA: Department of Statistics, South Africa. (2003). *Census 2001*. http://www.statssa.gov.za/SpecialProjects/Census2001/Census2001.htm (Current Jul. 22, 2003).

Stats SA: Department of Statistics, South Africa. (2005). *StatsSA*. http://www.statssa.gov.za (Current Jul. 8, 2005).

Telkom. (2003). "SAIX – The South African Internet eXchange", Telkom, http://www.telkom.co.za/. (Current Jul. 31, 2003).

Telkom. (2006). " Highlights of the Telecommunications History of South Africa", Telkom, http://www.telkom.co.za/ (Current Dec 6, 2006).

UCT: University of Cape Town. (2002). "News Article", GSB, UCT http://www.gsb.uct.ac.za/gsbwebb/defaultQuickPrint.asp?intpagenr=368, (Current Dec. 20, 2005).

UNDP: United Nations Development Program. (2003). "Millennium Development Indicators", United Nations Development Program, http://www.sarpn.org.za/documents/d0000875/docs/UNDP%20MDG%20Indicators%20-%202004.pdf. (Current Jul. 3, 2004).

Vecchiatto, P. (2005). "Campaign Aims to Get Schools Connected", *ITWeb*. Jun 17, http://www.itweb.co.za/sections/internet/2005/0506171047.asp?S=e-Learning%20and%20Business%20Education&A=ELR&O=FRGN. (Current Jan 8, 2007).

Weidemann, R. (2006). "2006: Finally, A Positive Year in Telecoms Terms", *MyBroadband*, Dec, http://www.mybroadband.co.za/nephp/?m=show&id=5202 (Current Jan 9, 2007).

Whitford, S. (2007). "Making a Case for Mobile TV", *Intrinsic Media*. Jan 3, http://www.mybroadband.co.za/nephp/?m=show&id=5274 (Current Jan 5, 2007).

Wolcott, P., L. Press, W. McHenry, S. Goodman, and W. Foster. (2001). "A Framework for Assessing the Global Diffusion of the Internet", *Journal of the Association for Information Systems*. 2(6), pp. 1 – 50.

World Wide Worx. (2004). "Executive Summary: Online Banking in South Africa 2004", World Wide Worx. http://www.theworx.biz/. (Current Dec. 4, 2006).

World Wide Worx. (2005a). "Great Expectations Stall on the Internet", World Wide Worx. http://www.theworx.biz/. (Current Dec. 4, 2006).

World Wide Worx. (2005b). "Executive Summary: VoIP in South Africa 2005", World Wide Worx. http://www.theworx.biz/. (Current Dec. 4, 2006).

World Wide Worx. (2005c). "Broadband in South Africa to Double Up", World Wide Worx. http://www.theworx.biz/. (Current Jul. 7, 2006).

World Wide Worx. (2006a). "Online Retail in South Africa 2006 – Broadband and Experience the Keys to Online Retail", World Wide Worx. http://www.theworx.biz/. (Current Jun.8, 2006).

World Wide Worx. (2006b). "Mobility 2006: Cost is the Key to Cellphone Banking", World Wide Worx. http://www.theworx.biz/. (Current Jan.5, 2006).

APPENDIX I: GLOBAL DIFFUSION OF THE INTERNET FRAMEWORK [2]

The analytic framework used here is laid out in "A Framework for Assessing the Global Diffusion of the Internet" [Wolcott et al. 2001], available at http://jais.isworld.org/articles/default.asp?vol=2&art=6. The framework was initially formulated in *The Global Diffusion of the Internet: An Initial Inductive Study* [Goodman et al. 1998], based on a more general analytic framework developed in *The Information Technology Capability of Nations* [Wolcott 1997]. The framework consists of *dimensions* and *determinants*. Dimensions are six variables, described following, that capture the state of the Internet within a country at a given point in time. Determinants reflect the factors that led to the observed state and will likely influence future development.

A useful analytic framework should be sufficiently rich that it captures the multifaceted diversity of countries' experiences with the Internet. At the same time, the number of variables should be small enough that they can be easily kept in mind. Each of the variables should describe an important, somewhat intuitive, and measurable feature of the presence of the Internet in a country. In a rough sense, the variables should form a complete set in that they collectively cover almost everything that might reasonably be of interest, and each variable should have something to offer to the overall picture that the others do not. Finally, for the framework to be useful, it must be feasible to measure the values of the variables given a modest investment of resources. If the analytic framework is based on variables that cannot be measured in practice, then its effectiveness is compromised.

The six dimensions of internet diffusion are shown in TableA-1.

Table A-1. Dimensions of the Diffusion of the Internet

Dimension	Description
Pervasiveness	Number of users per capita
Geographic Dispersion	Physical dispersion of infrastructure and access; primarily a function of the fraction of first-tier political subdivisions (states, provinces, governorates, etc.) with Internet points of presence (POPs).
Sectoral Absorption	Extent of connectivity in four social sectors: Education, Commercial, Health, and Government.
Connectivity Infrastructure	Capacity of the technical infrastructure; primarily a function of the capacity of domestic and international backbones, and the types of access (e.g. modem vs. high-speed) available to users.
Organizational Infrastructure	Internet services market characteristics; a measure of the richness, robustness, and level of choice of the Internet service provision market.
Sophistication of Use	Integration, transformation, and innovation; a measure of the nature of Internet usage by a leading segment of the user community.

The Internet within a particular country at a particular point in time may be assigned one of five levels along each dimension. A dimension/level approach was also employed by the United Nations Economic and Social Commission for Asia and the Pacific in its Technology Atlas Project [Technology Atlas Team 1989].

[2] This Appendix I is adapted from that in Foster et al. [2004]. Reproduced with permission.

Table A-2 illustrates distinctive features, common to all dimensions, of the levels. The levels should progress from less to more in an ordered way. Using an order of magnitude difference between levels has a number of advantages.

TableA-2. The Pervasiveness of the Internet

Level 0	*Non-existent*: The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country. There may be some Internet users in the country; however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1	*Embryonic*: The ratio of users per capita is on the order of magnitude of less than one in a thousand (less than 0.1%).
Level 2	*Established*: The ratio of Internet users per capita is on the order of magnitude of at least one in a thousand (0.1% or greater).
Level 3	*Common*: The ratio of Internet users per capita is on the order of magnitude of at least one in a hundred (1% or greater).
Level 4	*Pervasive*: The Internet is pervasive. The ratio of Internet users per capita is on the order of magnitude of at least one in 10 (10% or greater).

1. It increases the probability that two observers looking at the same country at the same point in time are likely to come up with the same assignments of levels, in spite of the fact that data about the Internet is often rapidly changing, incomplete, and of variable credibility.
2. While the measure is fundamentally quantitative, there is a qualitative aspect to the levels. When a country progresses from one level to another, the change is substantial enough that one is likely to observe a significant change in the impact and use of the Internet on a country.

While the "state" of the Internet at a given point in time within a given country can be captured using the dimensions outlined previously, it is perhaps more important to understand the factors that have caused the Internet to evolve to the state it has. Figure A-1 shows the collection of top-level factors that most strongly shape the nature and extent of the Internet within a country. Government policies are identified separately as a determinant because of their importance and because government policies usually impact the dimensions only indirectly, by shaping other determinants. The arrows reflect the direction of influence between the independent variables (determinants) and the dependent variables (dimensions) used in this study. This is not to imply that other influences do not exist. For example, government policy makers may formulate policies in part as a reaction to the state of the Internet itself.

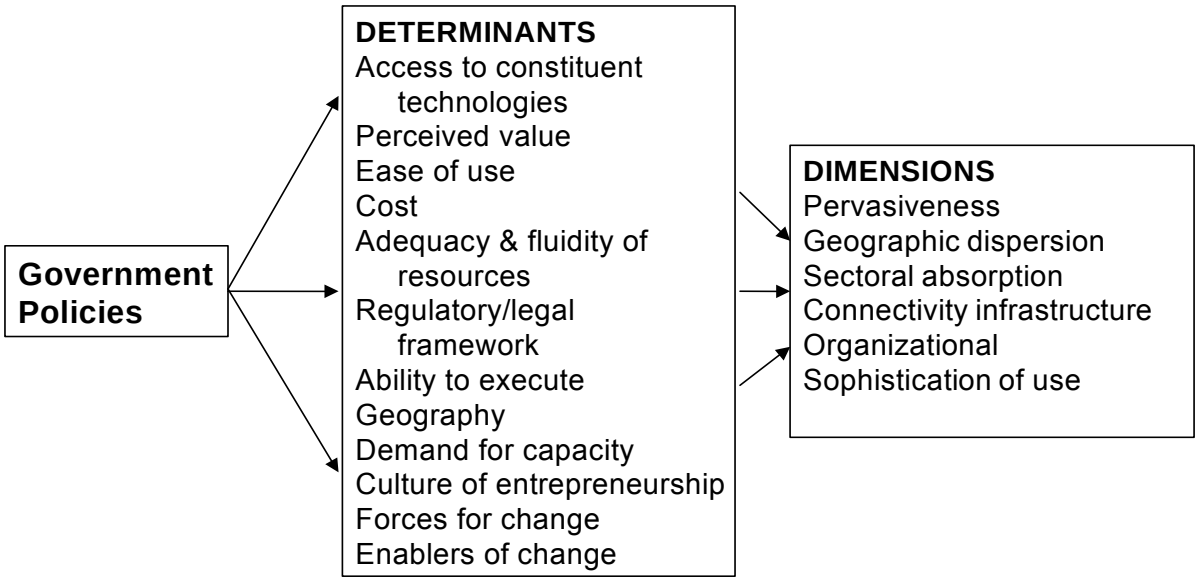


Figure A-1. Determinants of Internet Diffusion

Not all determinants have a strong impact on all dimensions. For example, pervasiveness is primarily a function of access to constituent technologies, perceived value, ease of use, and cost. If any of these factors is highly unfavorable, then individuals will not access the Internet, even if the other three factors are favorable. Identification of the subset of determinants most directly influencing particular dimensions can yield suggestions for policies that can promote (or hinder) development of that dimension.

In summary, the analytic framework employed in the global diffusion of the Internet project captures the state of the Internet within a country in a rich, multifaceted, yet relatively straightforward way through the use of dimensions. The determinants provide insight into factors shaping the Internet's evolution. Together, the dimensions and determinants provide an analytic tool that is helpful for conducting longitudinal studies and multi-country comparisons, and formulating policy recommendations.

ABOUT THE AUTHORS

Irwin Brown is an associate professor in Information Systems at the University of Cape Town, South Africa. He obtained his PhD from the University of Cape Town in 2005 by investigating the topic of Strategic Information Systems Planning. He has published in the *Information Resources Management Journal*, *International Journal of Information Management*, *Journal of Global Information Management*, *Journal of Global Information Technology Management, Electronic Journal of Information Systems in Developing Countries, Journal of Internet Banking and Commerce,* and *Educational Technology and Society Journal*.

Timothy Collins graduated with a Bachelor of Commerce degree in Information Systems (Honours) from the University of Cape Town in 2004.

Bantse Maleka graduated with a Bachelor of Commerce degree in Information Systems (Honours) from the University of Cape Town in 2004.

Denzil Morrison graduated with a Bachelor of Business Science degree in Information Systems (Honours) from the University of Cape Town in 2004.

Nixon Muganda is a lecturer in Information Systems at the University of Nairobi, Kenya. He enrolled for a PhD at the University of Cape Town in 2005. The topic of his research is e-Government.

Hilary Speight graduated with a Master of Business Science degree (Distinction) in Information Systems from the University of Cape Town in 2004.

Communications of the Association for Information Systems

ISSN: 1529-3181