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Economic Development Potential through IP Telephony for Namibia

Albertus Aochamub,¹ Daniel Motinga,²
and Christoph Stork³

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Abstract

The aim of this study is to evaluate the economic development potential for Namibia through IP telephony. First, background information on the telecommunication sector in Namibia is given. Then, the link between the ICT sector and GDP growth is being investigated. Granger causality tests indicated unilateral causality from GDP growth to telecommunications investment. Due to the small sample size, the causality tests could only be carried out for a lag length of 4, i.e. one year. The analysis might have yielded different result using a larger sample and a longer lag length. The potential impact of IP telephony for Namibia is evaluated using mainly descriptive means due to the lack of data availability. The conclusions drawn from this study are that IP telephony will affect developing countries sooner or later. IP telephony addresses two of the four cost factors of distance. It can make it cheaper to search for trading partners and reduce the cost of managing and monitoring distant production facilities. IP telephony offers the opportunity to improve competitiveness and to attract foreign direct investment, but it also poses the threat of being left behind if opportunities are not seized. In the final analysis, the paper argues that developing countries might be able to gain a comparative advantage by implementing IP telephony sooner rather than later.

Keywords: IP telephony, economic growth, telecommunications, ICT, Granger causality, Namibia

JEL classification: O10, O30, O40, O55

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¹ Iway (Windhoek); ² NEPRU (Windhoek); ³ NEPRU (Windhoek)

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UNU World Institute for Development Economics Research (UNU/WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

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1 Introduction

The Internet has already changed economic rules and systems. At its most basic level, the Internet lays down a communications infrastructure that is universal and inexpensive to access. It makes it possible for companies to communicate with all their stakeholders, and it is an ideal tool for precise commercial targeting of small groups of people with a common interest. While it threatens whole chains of commerce based on intermediaries, it also creates new Internet-based services to cater for the technically less informed and in so doing replaces those chains.

In general the Internet broadens the access of developing countries to information and markets. It offers a relatively cheap and efficient service complementing telephones and fax-machines. The Internet makes it possible to circumvent traditional distribution channels, which de facto means lowering barriers to entry, by allowing companies to sell their goods and services directly to customers. The Internet further promises to facilitate delivery of more even basic services such as health and education. The Internet can help to reduce the traditional disadvantages of developing countries, namely distance from markets, lack of basic infrastructure and under-utilized capacity.

The information and communication technology (ICT) sector in general is a key sector for economic performance and overall development (KPMG 2000). Advances in ICT increase competition by making supply respond to demand more effectively, putting pressure on prices. They can enable access to new markets and improve productivity through potential supply chain integration and restructuring of production processes. Advances in ICT can increase transparency, enable more effective utilization of information and improve the quality of existing information (by allowing information to flow faster and in a more targeted manner).

One of the recent ICT advances is IP telephony. Sarraf (2001) defines IP telephony as any telephony application that can be enabled across a packet-switched data network via the Internet protocol (IP). An IP telephone is a telephone that transports voice over a packet-switched network instead over a circuit-switched connection. IP telephony refers to the transfer of voice over the Internet protocol (VoIP).

IP telephony is already being widely used by large telecommunication companies around the world (CEPT 2001). IP technology will affect the structure and operation of networks and cause changes to cost and pricing models for services. IP technology is becoming established as the common technology for the next generation of networks (NGN). NGNs are likely to come in two flavours, a public NGN similar to the Internet, and the managed IP networks. Public Internet is a network of interconnected networks consisting of backbone networks with customer access through Internet service providers (ISP). A managed IP network is the same but offers greater control in areas such as access, security and charging (CEPT 2001). Players in the IP telephony field are traditional telecommunication companies, ISPs and IP telephony service providers (IPTSP).

The working hypothesis of this study is that a competitive telecommunication market reduces communications costs for all market participants and stimulates economic development. This study will evaluate the economic development potential for Namibia through IP telephony. First, background information on Namibia's telecommunication sector will be given. The following section investigates the link between the ICT sector and GDP growth. Then the potential impact of IP telephony for Namibian is evaluated.

2 Background telecommunication sector

Telecom Namibia is the only facility based operator providing local, long distance, international and leased line services in Namibia. The firm first offered its service in 1992. Until then, the government, through its Department of Posts and Telecommunications, was responsible for telecommunication and postal services. The department was dissolved in 1992, resulting in the creation of Telecom Namibia. Telecom Namibia is owned by the Namibia Post and Telecom Holdings (NPTH) which, in turn, is owned by the state. NPTH also holds 51 per cent of the shares of Mobile Telecommunications Ltd (MTC), which was awarded a mobile telecommunication license in 1996.

The Namibian Communications Commission (NCC) was established in April 1992 through the Namibian Communications Commission Act of 1992. Its functions include the licensing of private broadcasters, telecommunication and postal operators, radio spectrum management and other regulatory aspects. At the moment licenses are required for all telecom services except for leased lines, telex, and paging. License fees are required for mobile services, cable and satellite television. A mobile telecommunication license is valid for five years and for cable and satellite services one year only. NCC is dependent on neither Telecom Namibia nor Mobile Telecommunications Ltd, but reports to the Ministry of Foreign Affairs, Information and Broadcasting and is fully funded by the government.

A de facto regulatory vacuum exists for Telecom Namibia since NCC is not responsible for Telecom Namibia. Telecom Namibia falls under the supervision of the Ministry of Works, Transport and Communication, while MTC falls under the supervision of the NCC and therefore Ministry of Foreign Affairs, Information and Broadcasting. Telecom Namibia—due to this constellation and inadequate supervision by the relevant ministry—remains mainly unregulated. This affects pricing, rebalancing and service provision. Prices for local calls have, for example, increased since 1994 in real terms while prices for international and long distance calls have either increased or remained stable over that period. The new draft telecommunication bill that might be made public to stakeholders later in 2002 is likely to address this issue and to place the supervision of Telecom Namibia and MTC under the NCC. However, this is still speculation. There are also policies being drafted at present to deal with Internet service providers (ISP) and the ICT sector in general. These, however, have not yet reached the stage to be discussed publicly.

2.1 Fixed-line services

Considerable advances have been made in the telecommunications sector in Namibia over the last couple of years. Telephone network ports have grown annually by 9 per cent since 1995 and direct exchange lines annually by 8 per cent. The fixed-line teledensity (i.e. telephone lines per 100 inhabitants) increased from 3.11 per cent in 1992 to 6.41 per cent in 2002 (Figure 1 in the Appendix), while the number of installed telephone lines increased from 45,000 in 1992 to 120,215 in 2002.

The market for fixed-line services will be opened for competition in 2004. All market participants are currently required to use Telecom Namibia's international carrier gateway. In the case of Namibia, presently this is only the Mobile Telecommunications Ltd (MTC). There are no other fixed-line or mobile telecommunication providers in Namibia. Third party resale of lease line capacity is not permitted for either domestic or foreign firms. No private domestic or foreign ownership is permitted in the provision of fixed-line services

until 2004. Table 1 in the Appendix gives the revenues of Telecom Namibia for the period 1996 to 2000. Revenues have steadily increased and Telecom Namibia made an operating profit of N\$100 million in 2000.¹ Figure 2 in the Appendix displays the revenue per line and the number of fixed lines per Telecom Namibia staff. Both are increasing, indicating improving productivity. Table 2 in the Appendix details the capital investments of Telecom Namibia; there were no foreign direct investments. Telecom Namibia employed 1,667 people in 2000 or 04 per cent of the total labour force in Namibia. Table 2 in the Appendix also indicates the number of employees over the years 1993-2000.

The entire network is digital, and the average waiting time for the installation of basic telephone services is two weeks. The number of unsuccessful calls is logged at 58.98 per cent. No call back service is available. The fixed-line telephone service offered in Namibia is among the best in Africa. The *African Competitiveness Report 2000/2001* ranked Namibia as fourth for the number of telephones and affordability of telephone prices. The continuously improving performance, however, does not mean that nothing further can be done. The increase in real prices for most types of calls is an unnecessary burden to the development of Namibia. Rebalancing efforts do not explain the rises in real terms. Telecom Namibia has chosen a businesslike approach to prepare for unrestricted markets in 2004, and revenues have been steadily increasing in nominal as well as real terms. A monopolist following a business approach is bound to exploit its position and that has been the case for Telecom Namibia. Closer supervision and regulation of the telecom tariffs by the relevant ministry would have been beneficiary not only for consumers, businesses and the Namibian economy, but also for Telecom Namibia. During restructuring effort in a monopoly situation, increasing prices is the easier option to deal with but does not necessarily produce the most sustainable outcome.

2.2 Mobile services

The development for the mobile phone industry is remarkable in Namibia. MTC offers two services: the ‘tango card’ which is a pay-as-you-go service and a contractual or subscription service, or the ‘professional’ contract, which involves a monthly fee and has cheaper rates than the pay-as-you-go service. Mobile phone teledensity has increased from 0.96 per cent in 1998 to 6.97 per cent in 2002. The number of mobile phone users is already higher than the number of installed fixed telephone lines.

The higher growth of mobile phone subscribers compared to fixed-line users can mainly be attributed to population density and the geographical features of Namibia. A second mobile phone costs much less than the installation of an additional fixed line in a location where both networks are already established. Another factor is the ease of use of mobile phones, in particular with respect to tango cards. The time between the decision to purchase a mobile phone and to have it actually working can be as little as 15 minutes. This is reflected in the growth of subscribers using tango cards compared to subscribers using the contractual service offered by MTC.

A disadvantage of the mobile phone over fixed-line connections is its unsuitability for Internet use. This disadvantage could be overcome with the introduction of the ‘third generation mobile phones’ (UMTS). However, it may take several years until a third generation mobile phone network is established in Namibia.

¹ Roughly US\$10 million at April 2002 exchange rate.

Mobile Telecommunications Ltd (MTC) was awarded a mobile telecommunication license in 1996. The state-owned holding company (NPTH) holds 51 per cent of the shares of MTC. SwedeTel and SwedeFund hold the other 49 per cent. A second mobile telecommunication license was to be issued in 2001, but NCC did not have the funds to contract a consultant to issue a second license. This may be issued later in 2002 or at the beginning of 2003, bringing to MTC's mobile telecommunication monopoly to an end. No obligations regarding ownership have been imposed on the second mobile telecommunications license and it could be awarded to a foreign firm, through a competitive tendering process. NCC is responsible for licensing and spectrum allocation. The fee for a radio frequency is N\$10,500 million.²

Since the introduction of mobile telecommunication services, employment in the sector has increased in comparison to the fixed-line sector. It is also remarkable to note that in 2001 MTC with only 138 employees was able to provide a higher teledensity than Telecom Namibia with its 1,516 workers.

2.3 Internet services

The provision of Internet services is currently unregulated. A draft policy is being prepared and is expected to be submitted to parliament during the second half of 2002. Thus at the moment, there are no limitations with respect to market access or ownership. There are seven Internet service providers in Namibia: two are Internet access service providers (IASP). These are Infinitum and UUNet. Infinitum is a parastatal belonging indirectly to Telecom Namibia,³ whereas UUNet is a private company that belongs to the WorldCom group.

ISPs cannot build their own copper or fibre networks. They can, however, build networks with routers and switches using Telecom Namibia's cable network. ISPs are not allowed to own or lease their own international gateways. Interconnection agreements are left to private negotiations between parties. Two peering points are available—one privately owned (UUNet) and the other publicly owned (Infinitum).

As no policy initiatives to bolster Internet usage exist, service providers as well as consumer groups are consulted prior to regulatory decisions. The draft ISP policy is currently being reviewed by the NCC and, after approval of its board, will be submitted to the Minister of Foreign Affairs, Information and Broadcasting. Laws and regulatory decisions will be made public via the regulator's website and the official gazette.

There are roughly 12,000 Internet users that utilize fixed lines for Internet access and 8,000 users that access the Internet via leased lines. E-commerce is only possible through overseas banking facilities since no credit card facilities are available for e-commerce in Namibia yet.

The *African Competitiveness Report 2000/2001* ranked Namibia in first place in Africa for Internet access and second place for Internet hosts. However, more can still be done. As can be seen from Figure 5 in the Appendix, the real cost of accessing the Internet has

² Roughly US\$1,050 million at April 2002 exchange rate.

³ Infinitum and Telecom Namibia are 100 per cent owned by the Namibia Post and Telecom Holdings (NPTH). NPTH also holds 51 per cent of Namibia's mobile phone operator MTC.

increased due to a rise in local telephone rates, posing an obstacle to the spread of Internet use. One recent change is the introduction of nationwide Internet access numbers that are cheaper to use than the local call rates. However, the savings achieved with these numbers are just marginal. Competition in fixed-line services is likely to reduce Internet access costs considerably. Typically, voice calls are of much shorter duration than Internet calls, and local voice-call rates need to be higher than Internet rates to cover fixed costs. In OECD countries, these fixed costs are usually covered through local-call rate charges for the first 3 minutes. In a competitive fixed-line environment, ISPs would be able to negotiate a connection charge at the 3-minute local rate and then a fraction of the local rate for additional minutes. This would reduce the costs of a 20-minute Internet call considerably, thus promoting Internet usage.

3 ICT sector and economic performance

This section deals with the relationship between the ICT sector and economic growth. Researchers point out that it is important to distinguish between ICT industries and their contribution to growth and the role of ICT products as capital inputs to all sectors of the economy. Conclusions about the role of ICT can vary, depending on the perspective taken (Schreyer 2000). It is argued that the growth in the ICT sector and specifically in the telecommunications subsector, can lead economic growth in several ways. Investing in telecommunications infrastructure itself leads to growth because these products lead to increases in the demand for goods and services used in their production (Röller and Waverman 2001). In addition, the benefits or rather the economic returns to such infrastructure formation are much greater than the returns to the original investment, thanks to externality effects (Schreyer 2000.) Thus, there is a general hypothesis that the ICT sector generates spillover effects that exceed the direct returns to ICT capital, over and above their direct (and remunerated) contribution to output growth. If such effects are large indeed, they should translate into an acceleration of MFP growth, the overall efficiency with which combined inputs are used in the economy.

Various studies have been carried out, exploring these assertions mostly in OECD economies, but there have been limited studies focusing on non-OECD economies. This is partly explained by the data intensity of this process, as data are not always readily available for researchers in developing countries. Schreyer (2000) identifies three aspects to the measurement of the growth contribution of ICT:

- i) The first considers the role of ICT producers in an economy's total value added or GDP. Such an approach focuses on the production process of ICT goods. There is evidence that even with relatively small shares (ICT production as per cent of GDP), the contribution to overall output can be significant if ICT industries grow much faster than other parts of the economy. Further, if the rapid output growth in ICT industries is due to stronger increases in productivity in these industries, this contributes to macroeconomic productivity gains. However, looking only at ICT industries says little about the use of ICT in production.
- ii) The second approach focuses on the role of ICT in production. Computers and information equipment can be seen as a specific type of capital good, in which firms invest, and which they combine with other types of capital and labour to produce output. As Schreyer (2000) and others point out, when prices of

computer and information technology assets fall relative to other capital or labour, firms will substitute the latter for the former and change the way in which they combine various inputs in production.

- iii) The third approach is largely based on the claim that ICT produces benefits that go beyond those accrued to investors and owners—the so-called network externality effect.

3.1 Empirical evidence

Schreyer (2000) evaluates ICT sector contribution to output growth in the G7 countries. He employs a growth accounting framework. His key findings are:

- ICT capital goods are important contributors to economic growth but he concludes that there is little difference between ICT capital and other forms of capital. ICT as a capital input contributed between 0.1 and 0.4 percentage points per year to output growth of the private sector, depending on the country. Overall, the contribution of ICT capital to output growth has been significant and rising in relative terms. In the US, the growth contribution of ICT equipment/infrastructure amounts to about a half of the entire growth contribution of fixed capital. Where the contribution of ICT capital to output is smaller, as in France, Germany and Japan, it is due not so much to a slower rate of investment in ICT capital goods in these countries, but because of the lower income share of ICT capital goods.
- Regarding network externality effects of ICT inputs, the author finds, for the period 1985-96, few signs of a broad based uptake in multi-factor productivity. One caveat is that the data may be weak and may thereby compromise comparability across countries.

However, a study by Pilat and Lee (2001) found that OECD countries with a more rapid diffusion and lower costs of ICT technologies experienced a substantial pick-up in MFP growth in the second half of the 1990s.

A recent paper by Colecchia and Schreyer (2001) considers the relationship between ICT investment and economic growth in the 1990s for nine OECD countries. They find that ICT investment contributed between 0.2 and 0.5 percentage points per annum to economic growth over the last two decades for a sample of OECD countries.⁴ The paper shows that, despite differences between countries, the US has not been alone in benefiting from the positive effects of ICT capital investment on economic growth nor was it the only country to experience an acceleration of these effects.

A key shortcoming of the above studies is that they neglect causality issues, in the Granger sense. Finding a strong association between investment and growth does not necessarily imply a ‘causal’ relationship as explained by Madden and Savage (1998) in the context of telecommunication infrastructure growth and economic development. This is a critique espoused by Röller and Waverman (2001). In an attempt to breach this gap, Yoo (2001) examines the causality issue between telecommunications investment, a proxy for ICT investment, and economic growth using Korean data. He uses a vector autoregressive

⁴ Australia, Canada, Finland, France, Germany, Italy, the UK and the US.

framework based on recent developments in co-integration methodology and finds a bi-directional causality from telecommunications investment to economic growth and vice versa. This means that as much as increased ICT investment directly affects growth, the reverse growth impact of increased income is pertinent for ICT investment.

If there were a unidirectional causality running from telecommunications investment to economic growth, then a reduction in telecommunications investment could lead to a fall in income. A unidirectional causality running from economic growth to telecommunications investment might imply that higher GDP figures lead to higher telecom investments since telecom companies profit from more disposable income.

Also, Madden and Savage (1998) analyse the relationship between telecommunications infrastructure investment and economic growth for a sample of Central and Eastern European (CEE) countries. The study showed that overall, there appears to be two-way causality between the two variables at the aggregate level. Similarly, using data from 21 OECD countries over 20 years, Röller and Waverman (2001) consider how telecommunications infrastructure affects economic growth. They point out that reverse causality implies a distinction between two effects, namely:

- The increase in economic growth, which is attributable to increases in telecommunications infrastructure and service development; and
- The increase in the demand for telecommunications services, which is attributable to increases in economic growth (i.e. the income elasticity of telecommunication demand).

They proceed by estimating a simultaneous equation model for telecommunications investments and economic growth. After accounting for simultaneity and country- specific fixed effects, they find a causal relationship. A significant finding is that due to network externalities effects, which are pronounced in the region of universal service, increases in telecommunications infrastructure could create higher growth effects in OECD countries than in the less-developed non-OECD economies (Röller and Waverman 2001: 921).

3.2 Causality evidence for Namibia

This subsection examines the causality between telecommunications investment and economic growth for Namibia. It is legitimate to argue that there is a causal relationship between ICT investment and economic growth as increased telecommunications causes economic growth. We use telecommunications investment as a proxy ICT investment. Telecommunication investments penetrate to all parts of economic activities. The telecommunication sector not only serves as an input to other economic sectors, but also grows at a faster rate than other sectors. The use of telecommunication technology speeds up the process of information generation, collection and delivery, and allows quick access and responses to market information, and helps to enhance efficiency and to increase productivity. Thus telecommunication investments can be considered a good proxy for the ICT sector.

Careful consideration is given to the causality issues by applying modern rigorous techniques of Granger causality to Namibian data. Given that our objective is to explore the degree to which telecommunications investment Granger-causes growth and vice versa,

the variables of interest are real GDP, and the real telecommunications investment expenditure. The data are quarterly and covers the period 1997 (Q4) to 2001 (Q2).

The Granger causality test is quite straightforward (see Granger 1969). A time series (X) is said to Granger-cause another time series (Y) if the prediction error of current Y declines by using past values of X in addition to past values of Y. The successful application of this procedure hinges on non-stationary series. Granger and Newbold (1974) have shown that using non-stationary data in causality tests may yield spurious results.

Visual inspection of the plots of the two series suggests stable series, however, formal tests for non-stationarity are needed. Appropriate tests have been developed by Fuller (1976), Dickey and Fuller (1981) and others to test whether a time series is integrated of order one against the alternative of zero order integration. The augmented-Dickey-Fuller (ADF) test is employed to the integration level of the variables.

The ADF test results for a unit root confirm (see Table 6 in the Appendix) that the variables are integrated of order one in levels but integrated of order zero (i.e. stationary) in first differences. With a calculated tau-statistics of -1.571 compared to a critical value of -2.7042 at the 10 per cent significance level, the unit root hypothesis could not be rejected for real telecommunications variables. For real GDP it is possible to reject the hypothesis that the level variable has a unit root at 10 per cent significance level.

The application of this procedure to the first differences did reject the null hypothesis of the presence of a unit root at the 5 per cent significance level for both variables. A test-statistic of -3.437 was obtained for the first difference variable of telecommunications investment, which was higher than the critical value of -3.148 at the 5 per cent level of significance. Similar results emerge for the first difference variable of real GDP. Thus the results confirm that both variables have a unit root in their level, but the first differences, however, reject unit roots. In sum, the evidence suggests stationary series in first differences; hence we estimated the Granger causality models with first-differenced data. The test involves estimating the following regressions:

$$GDP_t = \sum_{i=1}^n \alpha_i TelInv_{t-i} + \sum_{j=1}^n \beta_j GDP_{t-j} + \epsilon_{1t}$$

$$TelInv_t = \sum_{i=1}^n \lambda_i TelInv_{t-i} + \sum_{j=1}^n \mu_j GDP_{t-j} + \epsilon_{2t}$$

where it is assumed that the disturbances are uncorrelated. Table 7 in the Appendix summarizes the results of the Granger causality test with F-values computed under the null hypothesis of no causality.

Since our F-value is smaller than the critical value for F of 3.48, we accept the null-hypothesis that telecommunications investment does not cause economic growth. Instead the causality runs from growth to telecommunications investment. This means that the inclusion of past values of GDP in the telecommunications investment equation provide a better explanation of current values of telecommunication investment than when excluded. The lag length is limited to 4 given the low sample size. It should be noted that this study

only lends support to the argument that an increase in real income, *ceteris paribus*, gives rise to telecommunications investment. Growth results in a higher proportion of national income being spent on telecommunications services and would stimulate further telecommunications investment. Intuitively increased economic growth requires enormous telecommunications investment.

3.3 Conclusion

The available data sample is too small to confirm the findings of Madden and Savage (1998) and Röller and Waverman (2001) for Namibia. However, unilateral causality from GDP growth to telecommunications investment could not be rejected. Due to the small sample size, the causality tests could only be carried out for a lag length of 4, i.e. one year. The analysis might have yielded different results with a larger sample and a longer lag length. Alternatively, in line with the findings of Röller and Waverman (2001), it could be the case that network externality effects are much lower in Namibia compared to OECD countries.

4 IP telephony

Cost advantages drive both access and core voice networks away from traditional circuit-switching towards IP packets. In global terms, the industry is still divided on the extent to which the vision of principally IP-based switching platforms is a realistic one and what combinations of solutions it will finally be based on. Will it be pure Asynchronous transfer mode (ATM), pure Internet protocol (IP), IP over ATM, IP over multi-protocol label switching (MPLS), or some combination of these?

IP telephony is a growing technological field that allows voice, data and video collaboration through existing IP telephony-based LANs, WANs and the Internet. By utilizing open IETF and ITU standards to move multimedia traffic over any network, IP gives users more choices in media (for example, coaxial cable, ISDN, POTS lines, ADSL, leased lines, satellite and twisted pair) and location. Consequently, the same networks supporting email and Web data traffic could increase their global connectivity to companies, individuals, and educational and social institutions. Businesses and individuals could reduce communication costs, and include video conferencing, application sharing and white-boarding tools.

Previously, separate networks were required to handle traditional voice, data and video traffic, which limited their usefulness. Each required separate transport requirements, making them costly to install, maintain and reconfigure. Integration was practically impossible. By blending voice, video and data and utilizing a common transport for each, it effectively merges three networks into one. The benefit to the consumer being easier manageability, lower costs for services and support and new tools for collaboration ultimately leading to increased productivity.

This section explores the critical ingredients of successful next generation network (NGN) architecture as it becomes widely available to handle voice over IP and also interconnect with the existing public switched telephone network (PSTN). Further, economic implications are evaluated in this section.

4.1 Technical aspects

It is important to commence discussion with the current circuit-switched networks before discussing the packet-switching environment. Both these technologies are the building blocks for 'next generation networks' (NGNs). In a circuit-switched environment (as shown in Figure 6 in the Appendix), network resources are reserved all the way from sender to receiver before the start of the transfer, thereby creating a circuit. All resources are committed to the circuit during the transfer. Control signalling and payload data transfers are separated in circuit-switched networks. Processing of control information and control signalling such as routing is performed mainly at circuit set-up and termination.

Numerous products are available over the Internet to cater for low-cost VoIP telephony. By way of revolution, Vocaltec Inc. introduced in the mid-1990s its software for an Internet phone designed to run on a 486/33-MHz (or higher) personal computer (PC) equipped with a sound card, speakers, microphone, and a modem. The software compressed the voice signal and translated it into IP packets for transmission over the Internet. This PC-to-PC Internet telephony, however, worked only if both parties were using Internet phone software.

Over the last few years Internet telephony has advanced rapidly. Many software developers now offer PC telephony software but, more importantly, gateway servers are emerging to act as an interface between the Internet and the PSTN. Equipped with voice-processing cards, these gateway servers enable users to communicate via standard telephones over great distances without going over the 'long distance' telephone network.

A call goes over the local PSTN to the nearest gateway server, which digitizes the analogue voice signal, compresses it into IP packets, and moves it onto the Internet for transport to a gateway server at the receiving end. This server converts the digital IP signal back to analogue and completes the call locally. With its support for computer-to-telephone calls, telephone-to-computer calls and telephone-to-telephone calls, VoIP represents a significant step toward the integration of voice and data networks.

Adding voice to IP networks requires a critical understanding of the system level challenges and how to cope with these. These challenges, amongst others, are interoperability, density, call control, call signalling, reliability, voice encoding, delay, echo, and all the elements that constitute the next generation networks. If Telecom Namibia is to harness the enormous potential of the voice-over IP technology platforms, a next generation network must be evolved. The benefits of NGNs, which enable transport of both voice and data over the same network, are numerous and can justify an investment to the tune of over N\$100 million (US\$10 million) for Telecom Namibia. Amongst others, it is expected that three key benefits will accrue to Namibian companies and the nation by extension, namely, cost savings on telephony, consolidation of numerous forms of communication media and increased usage of advanced multimedia applications.

This platform incorporates a distributed architecture in which the media gateway/bearer transport platform, signalling, call control, and application elements are divided into separate logical network components, communicating with one another through the use of intra-switch protocols such as Megaco, media gateway control protocol (MGCP), and SCTP/M3UA. A distributed model of this format allows different service providers to provide scaling possibilities of their networks to support numerous subscriber ports per node. What is envisaged here is that voice traffic moves between the traditional voice

network and the IP-based network with the aid of the media gateway. A soft-switch handles call control while the features and services are handled by an application platform. What transpires in reality is that the soft-switch (or call control platform) may actually support some of the more popular services without the aid of a separate application platform. Some examples where this might be the case are the caller name delivery, local number portability (LNP), and E-800 service. In a traditional PSTN environment the services are already implemented with the aid of service control points (SCPs). In all these instances, the call control platform will send intelligent network (IN) queries over the signalling system 7 (SS7) network to existing SCPs.

The next generation network is expected to accord telephone calls and access to services over IP-based data networks with improved cost/benefits to traditional PSTN-based platforms. The added advantages of scalability and flexibility of these networks allow IT practitioners additional scope for managing increased demands for a company's bandwidth with ease, as argued earlier.

The proliferation of IP-based applications and devices forces many service providers to offer consumers advantages which are in their favour in the form of cost reductions, simplification and consolidation of various communications media. It is expected that companies in Namibia can also enjoy similar benefits and hopefully translate those savings into new additional investment opportunities in the country's economy. The initial investment into next generation networks for Telecom Namibia might be thought of as mountainous at first but should be seen as offering longer-term benefits for the nation-state.

Based on current prices, an example for cost savings through IP-based VPNs offered by Infinitum, Telecom Namibia's IP operator, clearly argues the case for IP-based solutions for many Namibian corporations.⁵ Whether the organization simply operates within the national borders or has operations globally, the IP environment still offers the best choice by far. Treating voice traffic in a similar fashion can only add to the basket of cost reduction benefits that consumers and firms can expect to enjoy, should Telecom Namibia continue to roll out the relevant technologies.

Technical difficulties still to be resolved are quality of service (QoS) and numbering. Standards for VoIP quality and network reliability should be seen to be the same as that for traditional public switched networks. Every customer expects quality to be no less than what is currently available from the traditional telephone networks. IP-based voice is transparent to the customers. Features such as tone processing, packet play-out, voice activity detection (with comfort noise generation), and echo cancellation are key in meeting quality expectations.

While everyone makes much of the tremendous cost savings any corporate and nation can make with IP-based solutions, significant challenges still remain in the area of numbering. In other words, how do we address calls as they pass from the IP (packet-switch) environment to the circuit-switched? While it is already possible to terminate calls from the IP environment to numerous other networks, the reverse is still a challenge. A numbering scheme, which marries the two environments into one, still has to be evolved if VoIP is to realize its full potential of driving costs down for nations and enterprises.

⁵ See 'Businesses: Virtual Private Networks' on page 37.

Although much progress has been made to-date in introducing VoIP solutions globally, the analysis also highlighted challenges in the area of numbering and quality of service (QoS) concerns. If these challenges can be circumvented, Namibia as a nation can easily migrate towards next generation networks and take advantage of the expected results.

4.2 Economic impacts of IP telephony

IP telephony has the potential to provide comparative cost advantages. Internet uses the same lines of communication as standard telephones but uses digital technology, allowing more information to be carried at lower cost. Combined with wireless communication technology, it promises to provide wider universal services, to save costs, to allow more comprehensive services to be offered and to effectively combine different media formats (sound, data and picture).

However, several changes will be brought through IP telephony. Costs in certain areas will decrease and in other areas new costs will arise or existing cost positions will increase. The same is true for profits. This might threaten incumbent telephone providers but also provide new profit potentials. IP telephony must not be seen as a threat, but an opportunity, or at least as an alternative way to make profits. The essential question is: What is potential impact of IP telephony on the competitiveness of a country? Depending on the measures taken by the government, MTC and Telecom Namibia, the country could gain a competitive advantage or fall behind global developments.

Venables (2001) analyses the impact of new technologies on the economic convergence between developed and developing countries. He analyses how new technologies help to reduce the costs of overcoming distance. The profitability of a location depends on (i) labour costs; (ii) labour efficiencies; (iii) social infrastructure, and (iv) distance of the location to sources of supply and markets.

Venables (2001) splits the costs of distance into search costs, shipping costs, management costs and the cost of time involved in shipping to and communicating with distant locations. IP telephony addresses two of the four cost factors of distance, making it cheaper for Namibians to seek trading partners, and to reduce the cost of managing and monitoring distant production facilities. It makes VPN and international communications (video conferencing, voice, fax, etc.) cheaper.

4.3 Costs of service provision

A study by McGarty (1999) analyses the impact of IP telephony on the potential disaggregation of international and domestic telecommunication markets. McGarty concludes that (i) there is a convergence of networks, and (ii) a disaggregation of services and systems that takes place lowers any barrier to entry and dramatically expands the Internet market for any new entrants.

This development is mainly attributed to the cost advantages of IP networks compared to circuit-switched networks. The cost advantages that rise from sending voice over the IP are not so much attributed to reduced network element costs, but to the sharing of equipment and operation costs across data and voice networks (Sharma 2001a). An IP-based network, as an integrated infrastructure, allows greater standardization to support all forms of communication (voice, data, video, etc.). IP-based networks promise up to 70 per cent cost

savings on capital expenditure and operating costs (Sharma 2001a). Other estimates indicate the IP telephony can reduce network costs by a factor of 4 (CEPT 2001).

Table 8 in the Appendix compares the cost structure between a circuit-switched and an IP-based network. Costs for human resources in terms of wages are likely to be higher for IP networks. IP telephony requires less albeit higher skilled staff than circuit-switched telephony. This may pose a serious challenge to developing countries where highly skilled IT staff are in short supply. Another major cost saving factor of IP networks is the possibility to send compressed information. Sharma (2001a) estimates that transmission costs through IP telephony are between 40 and 60 per cent lower compared to PSTN networks due to compression on the backbone.

New costing models need to be developed for IP networks for pricing and regulatory purposes. The costs for a circuit-switched network are depended on distance and call duration. The costs of IP networks only indirectly affected by distance and call duration through the amount of traffic a call generates. Costing models for PSTNs have evolved over the years and take into account distance and time, but these cannot be applied to IP networks, where volume and time are the cost related factors instead of distance and time.

No answers can be given at present on what these costing models will look like, since standards have not emerged yet.

4.4 Revenues from service provision

Flat rates or volume pricing are the natural solution to the cost drivers of IP networks. Flat rates or volume pricing would need to generate enough income to pay for the investments required through the growth of data traffic. This implies a complete rethinking on the part of the operators on how to make a profit. Existing PSTN revenue streams from international and domestic long distance calls will shrink and revenue streams from local calls will increase. Offering value added services at lower costs through IP technology is likely to increase the demand for telecommunication services and hence replace some of the former revenue streams.

For developing countries, a further impact of IP telephony is the reduction in settlement payments. Developing countries are often on the receiving end of settlement payments. Under the international settlement system, payments are made when traffic from one country is greater than that going in the reverse direction. Net settlement payments are usually made on the basis of negotiated 'accounting rates' and traffic minutes. ITU estimated the net flow of settlement payments from developed to developing countries to be in the region of US\$50 billion during the 1990s. The IP telephony enables operators to develop alternative routing procedures using international IP backbones to avoid settlement payments.

Table 9 in the Appendix gives the actual average distribution of call revenues for 1999 to 2000, while Figure 8 displays the distribution of call revenues for the period 1995-2002. It can be observed that Telecom Namibia is very vulnerable to a reduction in national and international call revenues. During 1999-2000, national or international calls accounted for nearly 75 per cent of total revenues.

A new player in the fixed-line market could threaten the existence of Telecom Namibia, should this provider base its entire network on IP. A second fixed-line licence is bound to be awarded in 2004, and a potential candidate for this licence could be MTC or NamPower. NamPower is the national electricity provider and already owns an extensive fibre network. NamPower might also join forces with MTC or another mobile telecommunication provider.

Urgent steps are required by Mobile Telecommunications Ltd and Telecom Namibia to prepare for the anticipated changes in revenue streams. Cost savings introduced by IP networks can either be put to other use by consumers and businesses, or be translated into a higher demand for added services. It is up to Telecom Namibia and MTC to design new products and services to capture the freed disposable income.

4.5 Universal service obligation

A universal service obligation (USO) is often imposed on the dominant telecommunication operator. It is an obligation to provide basic access to telecommunication services to anyone who reasonably requests it. It often involves extending network infrastructure to unserved areas. Telecom Namibia has such a roll-out obligation. Universal service is seen by the government of Namibia to entail:

- Assured access to all existing users;
- The provision of access to the national telephone network to all potential users;
- The provision of services on standard terms and conditions; and
- The provision of services on affordable terms.

Presently Telecom Namibia justifies the country's high international and national call rates with its universal service obligation. This type of cross-subsidization is threatened by IP telephony. There are, however, alternative concepts, such as charging VoIP providers for access to the PSTN in order to fund the USO, or applying a levy on minute traffic. However, IP technology might also help to fulfil the USO since it is cheaper to run and services can be offered for less than PSTN services. The USO could also be extended to mobile telecommunication and VoIP providers.

4.6 Interconnections and prices

Switching from PSTN to IP-based networks will affect the cost structure of providing telecommunication services. This will involve the unbundling of network elements, and defining technical issues such as the quality of service. It will also alter the circumstances on which some key interconnection functions such as call origination and call termination have been based. The interconnection agreements between Telecom Namibia and MTC (which need not be made public) are determined through private negotiations. End user tariffs are not regulated for fixed-line services, but price caps are set by NCC for mobile call rates. Market forces can only partly influence these prices since there is no other fixed-line operator in the country except Telecom Namibia. Negotiations are biased due to MTC's dependence on using Telecom Namibia's backbones and international gateways; MTC pays the same amount as any other user even though it is Telecom Namibia's biggest

customer. For example, Telecom Namibia applies the same rate for an individual's call from a fixed-line telephone to another fixed-line telephone as it does for MTC making for a mobile call to a fixed-line telephone. Considering that MTC generates more volume on Telecom Namibia's network than Telecom Namibia itself, one would expect there to be volume discounts for MTC. This would certainly be the case in a competitive environment, leading to lower mobile call rates.

Call rates applied by Telecom Namibia are unregulated. Tables 10 and 11 in the Appendix show Telecom's nominal and real prices for 1994 to 2000. According to Telecom Namibia, there is frequent rebalancing, but prices have continued to increase in real terms for local, long distance as well as international calls since 1994. MTC call rates, on the other hand, are regulated by NCC through price caps. Tables 12 and 13 in the Appendix show the price development for 'tango' and professional subscribers. Prices from cell phones to fixed-line telephones could be considerably lower if MTC were able to negotiate volume discounts with Telecom Namibia.

The price of international calls via cell phones is effectively fixed by Telecom Namibia since MTC has to use their international gateway. All calls abroad (except for South Africa) cost N\$1.96 during the peak period and N\$1.22 during the slow period, plus the Telecom Namibia rate for the destination. Here, too, calls could be cheaper if volume discounts were possible. A second alternative would be to grant MTC an international gateway license. This would reduce international call charges considerably, and calls abroad through a cell phone could become even less expensive than through a fixed line. Competition would suppress international rates, bringing them closer to the level of actual costs. Telecom Namibia revenues could shrink considerably since roughly 50 per cent of their revenues come from international calls. Once full competition is in place, interconnection arrangements could be left entirely to market forces, but until then, regulation of interconnection agreements through NCC could be advantageous for consumers as well as the Namibian economy.

The evolution of IP telephony will provide consumers with benefits in one way or another. The transmission quality over managed IP networks will be similar to circuit-switched networks in the medium term. At the same time, IP telephony will be considerably cheaper and will unify different communication forms (voice, video and data) to deliver enriched services. The consumers selecting IP telephony will benefit from cheaper communication costs, while those who remain with conventional telephony will have the advantage of lower prices because of the IP telephony competition. Table 14 in the Appendix compares the cost savings that can be realized already today, based on the prices of Telecom Namibia, MTC and Net2Phone.

With the exception of calls to Johannesburg, Net2Phone is at least 10 times cheaper for all destinations. Voice quality will be higher on PSTNs versus IP networks for some time to come, but quality differences are decreasing continuously. Telecom Namibia might offer both PSTN and IP services simultaneously until a time when there will be no difference in the quality of service (QoS). IP telephony could be marketed as an economy class service at lower rates, making it possible for the poor, in particular, to use these access opportunities more, in view of the fact that Namibia has one of the highest income disparities in the world.

4.7 Businesses with virtual private networks

Businesses can also profit from IP telephony/IP networks in the form of lower call charges. However, major savings are already possible today under the existing regulations. Virtual private networks can already be based in Namibia on an IP network without any violation of regulations.

A virtual private network (VPN) allows clients to access the low-cost shared resources of the public Internet, thus replacing the expensive private intranets which most companies had utilized until recently. These private networks offer security, reliability, and control but are inflexible with regard to upgrades since they are based on fixed infrastructure, and the costs of administration tend to be exorbitant as well. A VPN offers a less expensive solution over a public network with dedicated bandwidth, as well as secure performance through the use of encryption and firewalls. VPNs are also fairly flexible and scalable. Bandwidth can be expanded in real time and, in most instances, within 24 hours for infrastructure. Flexibility and scalability give IT managers room to manoeuvre in the face of increased pressures on bandwidth in most corporate settings. The benefits for corporate end-users in a nutshell are:

- The ability to enjoy the cost benefits of Internet telephony without the need for capital investments or new network management infrastructure;
- The ability to realize cost savings for internal corporate calls while utilizing the public Internet telephony network for calls outside the company
- The ability to control corporate network configurations and routing while outsourcing management and operations to the service provider; and
- Quick, flexible upgrade of network capacity as required.

The benefits for service providers include:

- New revenue streams through VPN services and bandwidth utilization;
- Service to companies that extend from simple bandwidth to full-service network operations for fax, voice, and data;
- Total solution for all of the customer's communication needs;
- Enhanced competitiveness against direct solutions from router and PBX vendors; and
- Reduced costs through the consolidation of voice, fax, and data traffic into a single network—and with a single administrative centre.

NEPRU carries out a semi-annual business climate survey. The first survey in 2002 included questions on the spread of computers and Internet use, as well as telephone costs typically incurred by businesses. The survey was carried out using random sampling across regions and sectors. Fieldworkers visited the chosen business-places for personal interviews. This was done to guarantee a high response rate. The results, given in Tables 15 and 16, represent the responses from 331 firms out of the sample total of 400. The response rate is usually close to 100 per cent; deviation caused by a delay in responses.

Figure 9 in the Appendix gives the percentage distribution of employment for the different economic sectors of Namibia. It represents a typical breakdown of the country's economy, with many small and a few large companies. Sixty per cent of the sampled companies had less than 11 employees, and only 5.1 per cent had 100 or more. As can be seen from Figure 9, most of the sampled companies employed between 1 and 10 employees. Thirteen per cent of the manufacturing companies employed more than 50. Roughly 40 per cent of companies in manufacturing, wholesale and retail trade, tourism and financial services employed between 11-49 people. Table 16 in the Appendix indicates the number of computers for the different-sized companies, and companies in tourism and the financial services are the most intense computer users. These are also the sectors with a relative higher average employment numbers. Eighty per cent of the companies in the tourism sector, and 70 per cent of the firms in financial services had between 1-5 computers. There is considerable advantage for the tourism sector to utilize the computer and Internet because large proportion of tourist come from abroad. The finance sector around the world counts on the early adopting sector of ICT due to the nature of its transactions. It was surprising to note that 64 per cent of the agricultural enterprises have 1-5 computers although most (80 per cent) employed 10 or less workers. A plausible explanation for this is the country's focus on commercial farm enterprises.

Compared to OECD countries the number of computers per employee is still low in Namibia albeit relatively high for Africa. Some respondents (16.5 per cent) use the Internet to buy goods and services and 10.8 per cent to sell goods and services. Figure 10 in the Appendix highlights the breakdown of companies according to the average monthly amounts spent for telephone bills. Of the samples companies, roughly 20 per cent could benefit from IP-based VPNs, i.e. those spending N\$5,000 or more per month.⁶

Tables 18 and 19 demonstrate the above mentioned benefits. It is assumed that a company has three points of presence (POPs) in Namibia with a branch in Johannesburg, South Africa. If the company were migrate its network from the classic PSTN environment with a physical pipe (Digicon) link to one serviced through an IP-based network, the savings are tremendous. Even if extra costs were incurred to add a firewall to secure the company's data, the costs are still be relatively lower than in the classic environment.

The example does not account for the second half of the intercontinental link, which the PSTN operator in South Africa is responsible for, so these savings could be even higher. Including these costs in the equation would increase the costs of a traditional link-up. In the real-life example in Table 18 (with actual data from Infinitum, Telecom Namibia's IP operator), the monthly savings are over N\$22,900 for a 64kbit/s connection and almost N\$41,300 for a 128kbit/s connection.⁷

5 Conclusions

The aim of this study was to evaluate the economic development potential for Namibia through IP telephony. It has not been possible so far to determine how much GDP growth can be expected from the introduction of IP telephony. Further research based on this study

⁶ Roughly US\$500 at April 2002 exchange rate.

⁷ Based on information from Infinitum. Amounts correspond to approximately US\$2,290 and US\$4,130 at the April 2002 exchange rate.

will hopefully be soon able to provide relatively accurate estimates. But availability and consistency of data are major difficulties which need to be overcome. This would call for a significant effort to be made in order to build a macroeconomic model for Namibia.

The available data sample to test for causality between ICT investments and GDP growth has been too small to confirm the bi-directional causality found by Madden and Savage (1998) and Röller and Waverman (2001). However, unilateral causality from GDP growth to telecommunications investment could not be rejected. Due to the small sample size, causality tests could only be carried out for a lag length of 4, i.e. one year. The analysis might have yielded different results if a larger and a longer lag length had been possible. Alternatively, in line with the findings of Röller and Waverman (2001), it could be the case that network externality effects are much lower in Namibia than in OECD countries.

Sharma (2001a) suggests the following strategies for dealing with IP telephony for incumbent operators in different market circumstances.

- 1) For developed economies with a telephone penetration density of over 50 per cent:
 - Utilizing existing PSTN while reducing or even cancelling investments in it;
 - Lowering the costs of PSTN services (effective management, new technologies, reducing operating costs, etc.); and
 - Speeding up the development of broadband IP network and providing value added services (video conferencing, VPN, etc.).
- 2) Economies with a telephone penetration density between 10 and 20 per cent and high growth rates:
 - Avoiding premature redundancy of PSTN investments, by making full use of network resources and offering supplementary services;
 - Building up a moderate IP network;
 - Tariff rebalancing by lowering the costs of PSTN services (effective management, new technologies, reducing operating costs, etc.) to compete with IP telephony;
 - Lowering investments for long distance PSTN; and
 - Introducing innovative services to attract more demand for telecommunication services.
- 3) Economies with a telephone penetration density between 3 and 5 per cent and high growth rates:
 - Continue developing a PSTN structure;
 - Using IP technology in backbone network of long distance operators;
 - Obligating new entrants using IP telephony imply to USO targets;

- 4) Economies with a telephone penetration density below 3 per cent:
- Reducing reliance on international traffic.
 - Pricing models according volume or flat rates to increase Internet usage and foster Internet based service market.

According to Sharma (2001a) it is in general a good idea to gradually migrate the core network for voice services to IP technology. As Namibia would fall in the second group with teledensity between 10 and 20 per cent (mobile plus fixed-line teledensity together), following recommendations are derived from this study:

5.1 Telecom Namibia

Telecom Namibia will eventually see a shift in their revenue streams through IP telephony. The ITU report on IP telephony (ITU 2001) states that incumbent operators are likely to experience a loss of international traffic revenues, both direct (loss of collection charges) and indirect (loss of settlement payments)—an outcome clearly expected for Telecom Namibia. Thus the company is advised to acknowledge IP telephony, and bear the consequences of reduced per minute revenues from long distance and international calls, rather than risk missing the opportunity to develop future revenues in new areas of growth. Consequently Telecom Namibia can no longer cross-subsidize local rates and its USO with long distance and international calls. In anticipation of these changes, a tariff rebalancing will be required to synchronize prices for the different types of calls. Thus, increased revenues from local calls will partly make up for the reduced earnings from national and international calls. This is made possible by higher local rates and greater local volumes induced by VoIP and Internet traffic. Telecom Namibia will also need to accelerate the transformation process and to invest heavily in the next generation network in order to be prepared for the competition that will accompany the second fixed-line provider in 2004. IP networks enable new players such as utility providers (NamPower, e.g.) to gain easy market access and to compete with much lower cost structures. This poses a direct threat to the existence of incumbent operators. Offering new IP based services and products can collect some of the cost savings brought about by IP telephony. Also cheaper call rates will attract more minute turnover.

5.2 Namibian Communications Commission (NCC)

A new ministry should be formed, or the supervision for the telecommunication sector should be placed under one ministry. NCC should be responsible for fixed-line and mobile telecommunication services. It would be advisable for NCC to define technical standards such as QoS and to regulate fixed-line prices until full competition becomes effective. This should be done in a way to allow and to motivate Telecom Namibia to migrate gradually to a next generation network (NGN), to protect consumers and foster the use of Internet and other communication means. Approaches to IP telephony should be technologically neutral, i.e. regulations should be applied fairly to similar services, regardless of the technology used to provide these services. This supports competition amongst technologies and operators.

5.3 Government of Namibia

Import duties should be reduced or cancelled for ICT goods and services, in particular for Internet-related products such as routers, switches, hubs, servers, etc. to enable major players easier transfer to NGNs. The merits of VAT exemption for ICT goods and services should be evaluated in order to reduce costs of ICT technologies. The recommendation is based on the findings of Pilat and Lee (2001) that OECD countries with a more rapid diffusion and lower costs of ICT technologies experienced a substantial pick up in MFP growth in the second half of the 1990s. Provision of free or cheap Internet access is proposed to institutions such as schools, universities, libraries and other public service institutions. The use of the Internet can be promoted and access of the poor to communication services increased. This could facilitate access to services such as e-learning and e-health.

Distance is one of the major obstacles to globalization. IP telephony addresses two of the four expense factors of distance: (i) search costs, (ii) shipping costs, (iii) management costs and (iv) cost of time for shipping and communication with distant locations. IP telephone would make it cheaper for Namibians to seek trading partners, and it would also reduce the cost of managing and monitoring distant production facilities. It makes VPN and international communications (video conferencing, voice, fax, etc.) cheaper. While IP telephony offers the opportunity to improve competitiveness and attract foreign direct investment, it also poses the threat of being left behind if opportunities are not realized.

Namibia already has a fully digital telephone network. Transforming this network to a NGN that offers IP telephony on various levels and, through this, drastically reduce the costs of communication would translate into a considerable gain in competitiveness for both Telecom Namibia and the nation-state.

Appendix

List of abbreviations	22
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List of figures

Figure 1	Fixed-line teledensity	23
Figure 2	Telecom Namibia's performance, 1993-2001	23
Figure 3	Mobile teledensity	24
Figure 4	MTC subscribers	24
Figure 5	Internet access costs	25
Figure 6	PSTN, circuit-switched	25
Figure 7	Next generation network (NGN)	26
Figure 8	Revenue distribution of Telecom Namibia, 1995-2002	26
Figure 9	Percentage distribution of employment for different sectors	27
Figure 10	Average telephone bills in % of businesses in Namibia, 2002	27
Figure 11	VPN example	28

List of tables

Table 1	Telecom Namibia data (N\$ million)	29
Table 2	Employment and capital investments for Telecom Namibia	29
Table 3	MTC employment	29
Table 4	The six biggest ISPs in Namibia	29
Table 5	Correlation coefficients for OECD countries	30
Table 6	ADF test for unit roots	30
Table 7	Pairwise Granger causality tests	30
Table 8	Comparison of IP and circuit-switched networks	31
Table 9	Average monthly revenue breakdown for Telecom Namibia, 1999-2000	31
Table 10	Telecom Namibia nominal prices during peak time	31
Table 11	Telecom Namibia real prices during peak time in 1994 prices	32
Table 12	MTC nominal tariffs for professional subscribers	32
Table 13	Nominal tariffs for tango subscribers	32
Table 14	Price comparison for consumers in Namibia \$	33
Table 15	Number of computers for employment categories	33
Table 16	Number of computers for companies from specific sectors	33
Table 17	Number of computers with Internet access	33
Table 18	VPN 64kbit/s international link, three nodes plus Johannesburg	34
Table 19	VPN 128kbit/s international link, three nodes plus Johannesburg	34

List of abbreviations

ATM	Asynchronous transfer mode
CEE	Central and Eastern European countries
GATS	General Agreement on Trade in Services
GSM	Global System for Mobile Communications
IASP	Internet access service providers
IN	Intelligent network
IP	Internet protocol
IPTSP	IP telephony service providers
ISDN	Integrated service digital network
ISP	Internet service provider
ITU	International Telecommunication Union
LAN	Local area network
LNP	Local number portability
Mbps	Million bytes per second
MFP	Multi-factory productivity
MGCP	Media gateway control protocol
MPLS	Multi-protocol label switching
MTC	Mobile Telecommunications Ltd.
NCC	Namibian Communications Commission
NEPRU	Namibian Economic Policy Research Unit
NGN	Next generation network (IP)
NPTH	Namibia Post and Telecom Holdings
OECD	Organization for Economic Cooperation and Development
POPs	Points of presence
PSTN	Public switched telecommunications network
PTOs	Public telecommunication operators
QoS	Quality of service
SCPs	Service control points
SS7	Signalling system 7
TDM	Time division multiplex
UK	United Kingdom
UMTS	Third generation mobile phones
UNAM	University of Namibia
USO	Universal service obligation
VANS	Value added network services
VoIP	Voice over IP
VPN	Virtual private network
WAN	Wide area network
XDSL	X digital subscriber line

Figure 1
Fixed-line teledensity

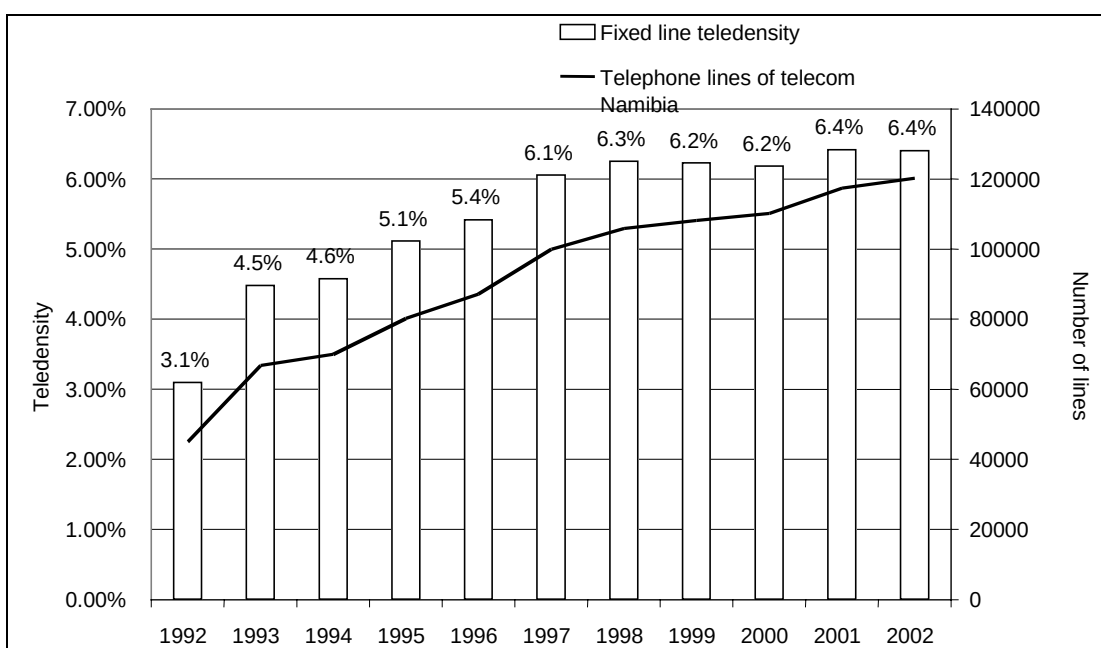


Figure 2
Telecom Namibia's performance, 1993-2001

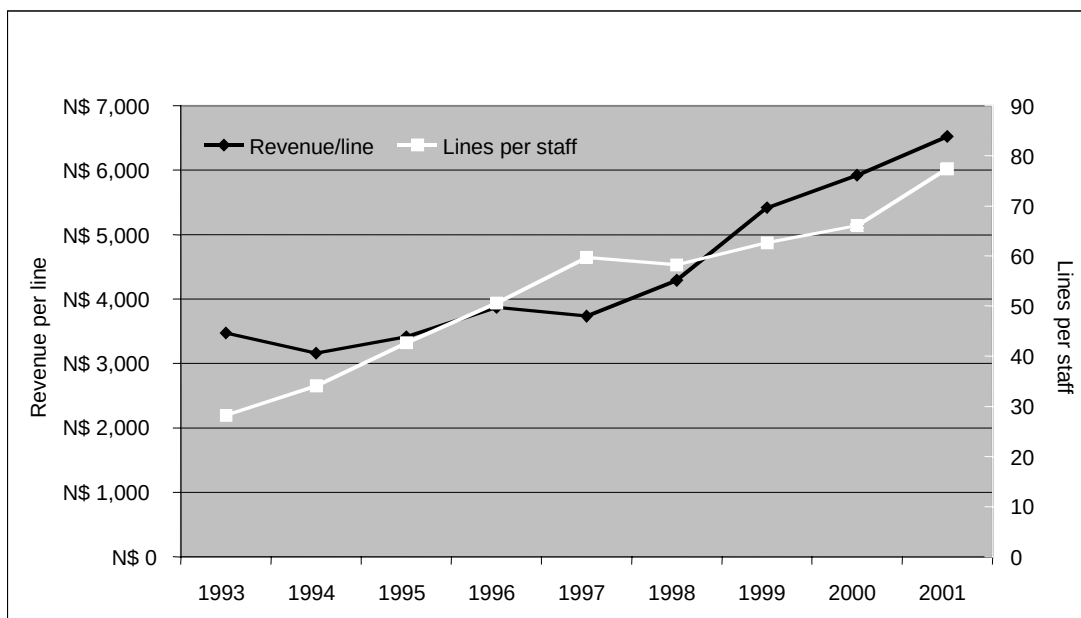


Figure 3
Mobile teledensity

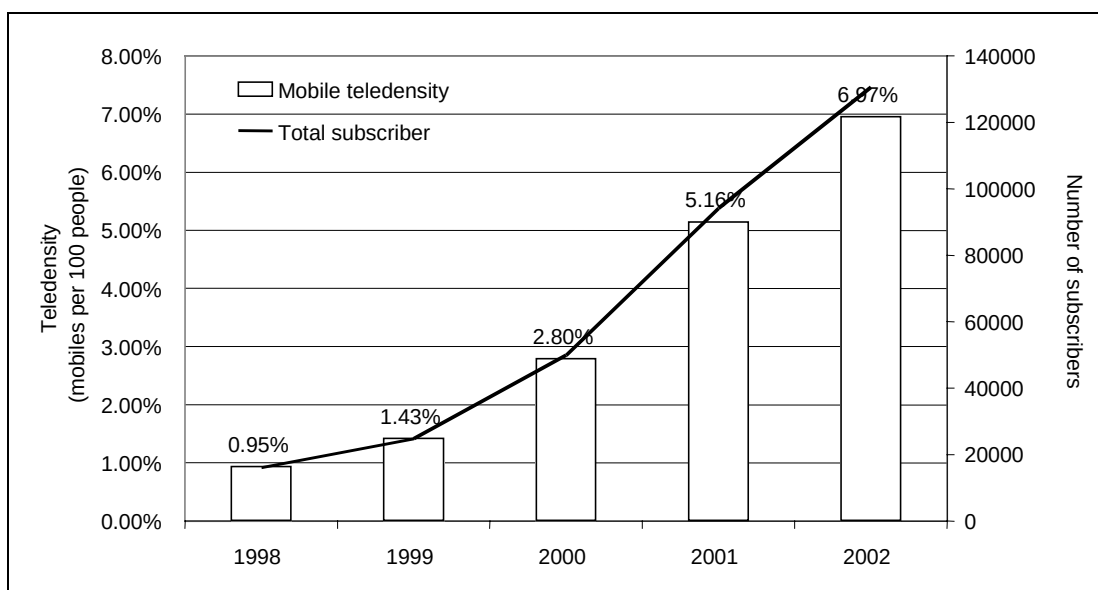


Figure 4
MTC subscribers

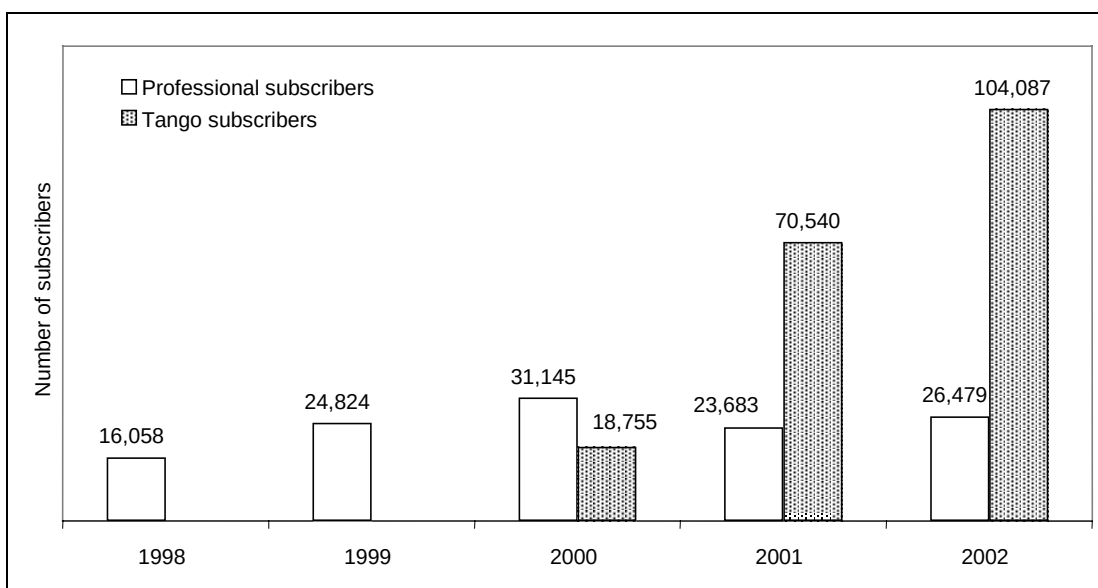


Figure 5
Internet access costs

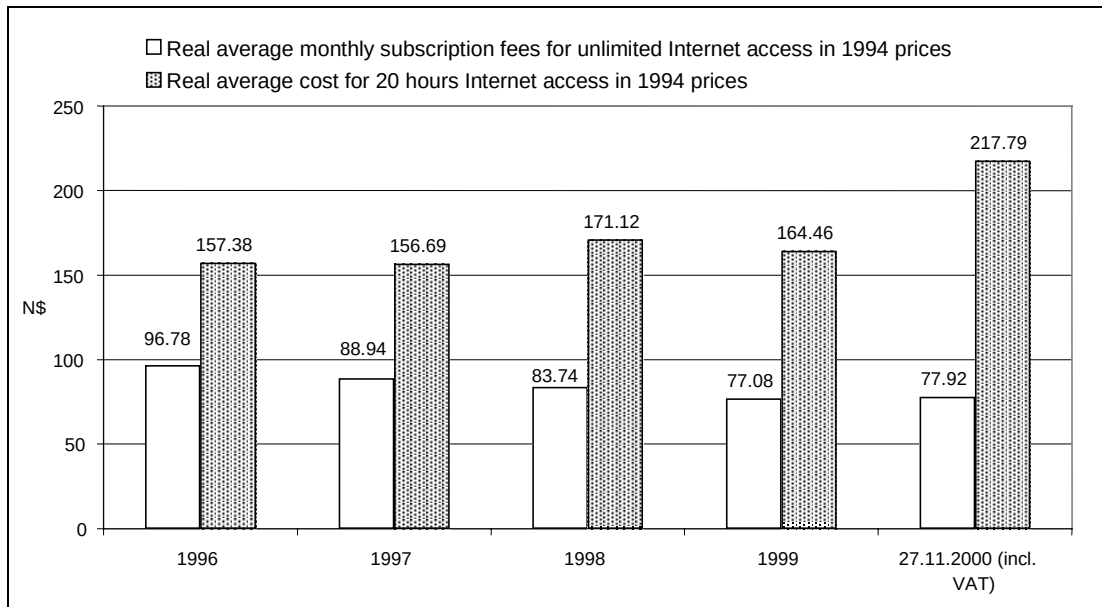
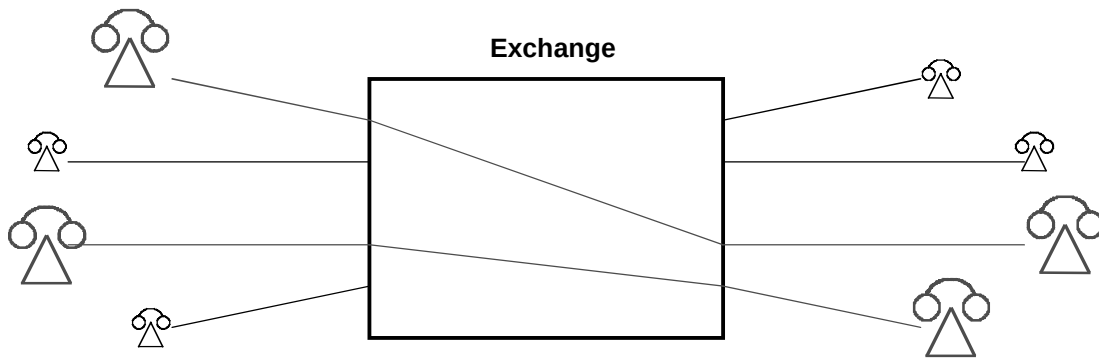


Figure 6
PSTN, circuit-switched

'Circuit switched'—'traditional voice'—PSTN



Source: Telecom Namibia (2002).

Figure 7
Next generation network (NGN)

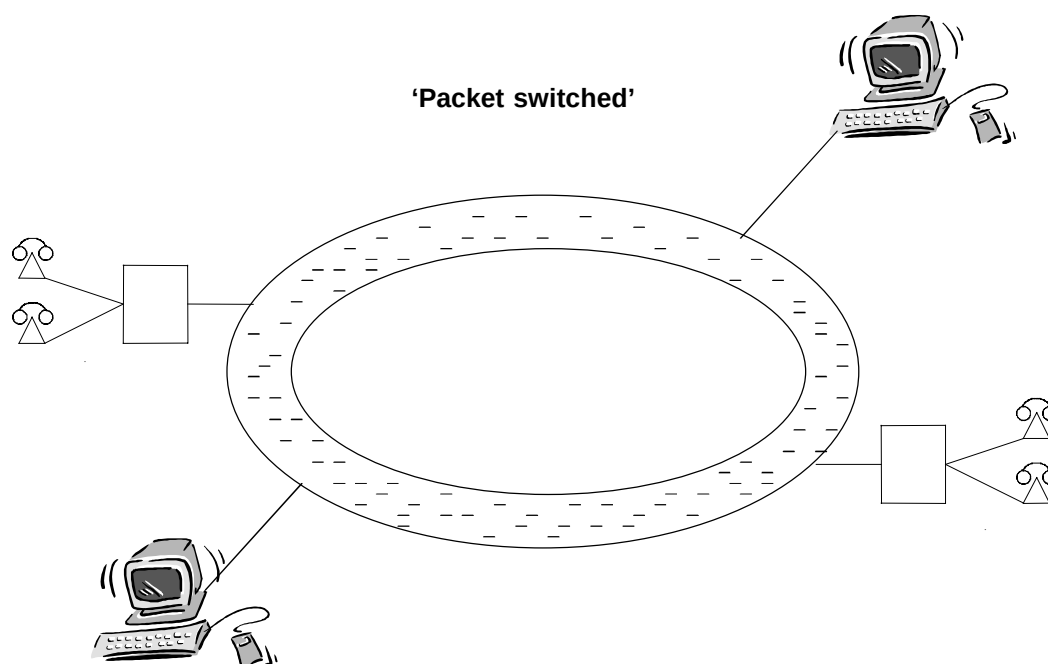


Figure 8
Revenue distribution of Telecom Namibia, 1995-2002

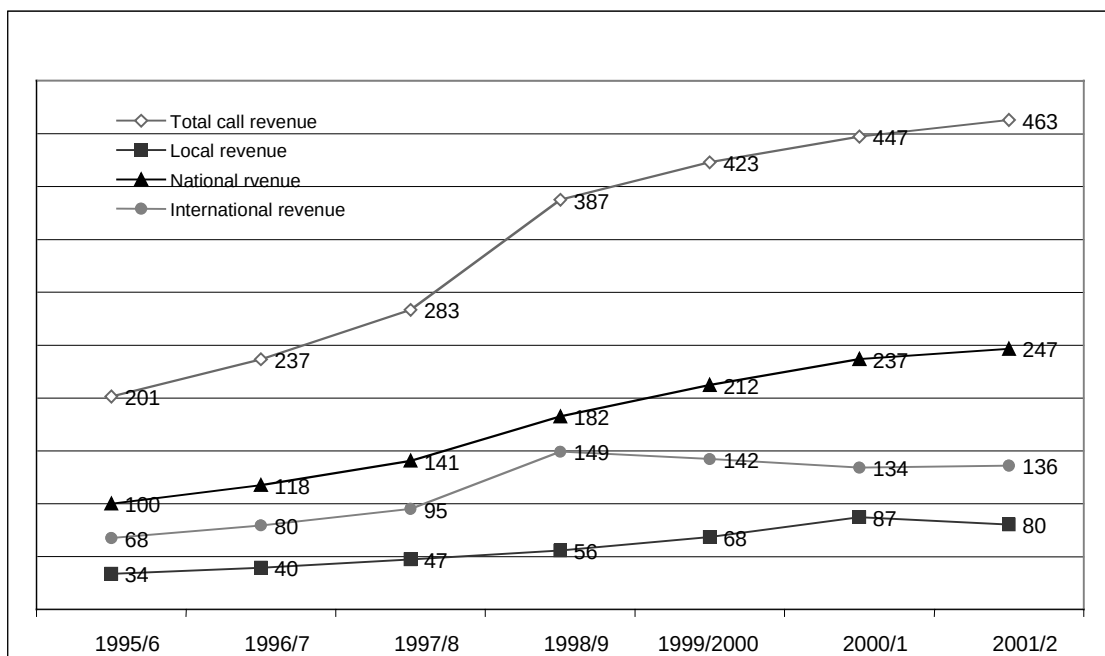


Figure 9
Percentage distribution of employment for different sectors

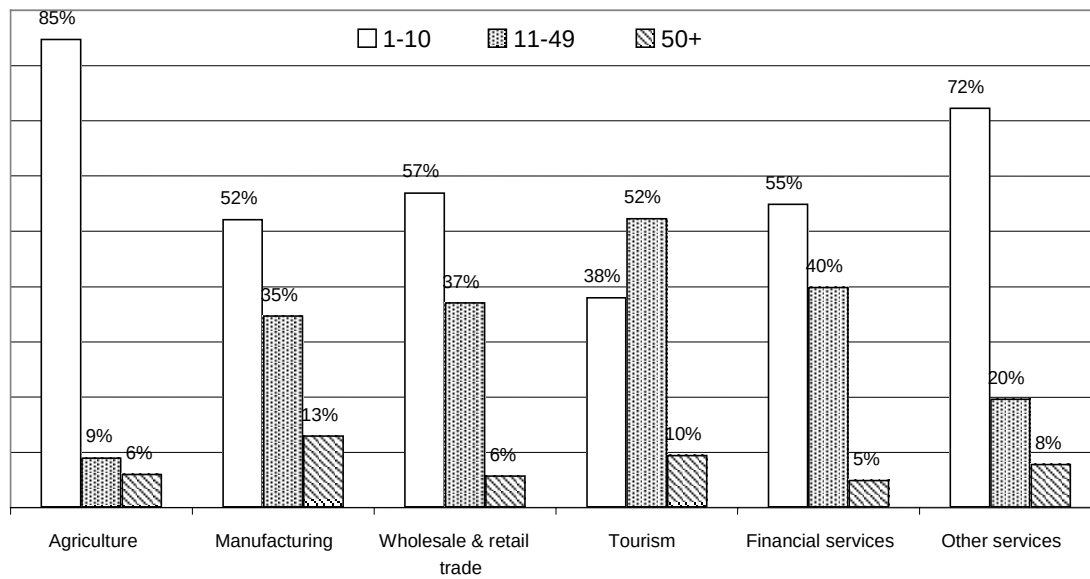


Figure 10
Average telephone bills in % of businesses in Namibia, 2002

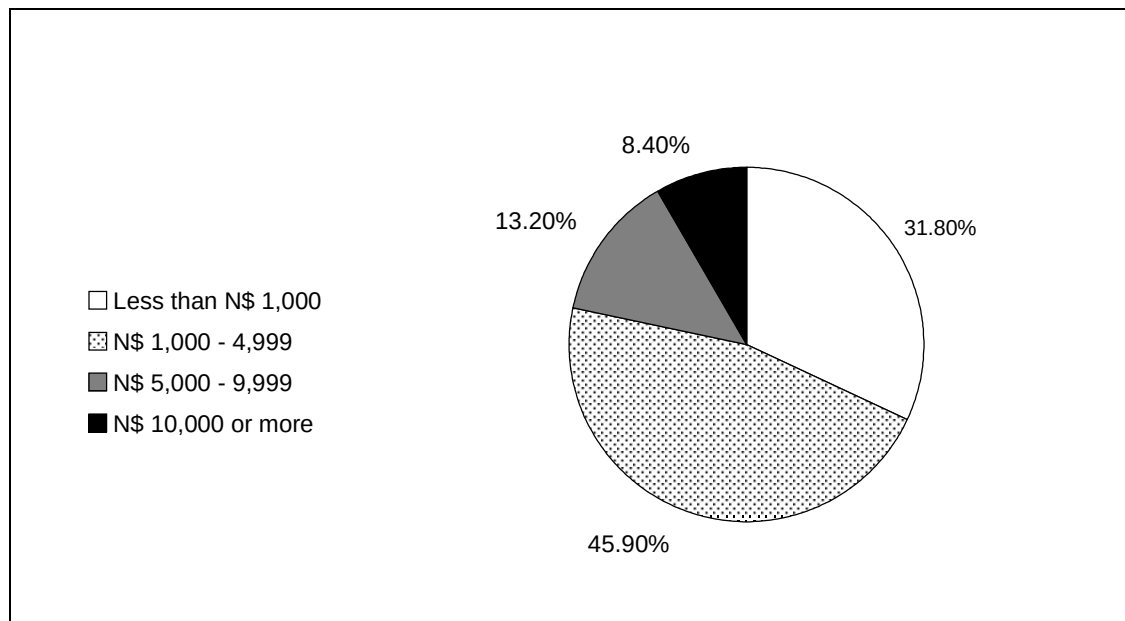


Figure 11
VPN example

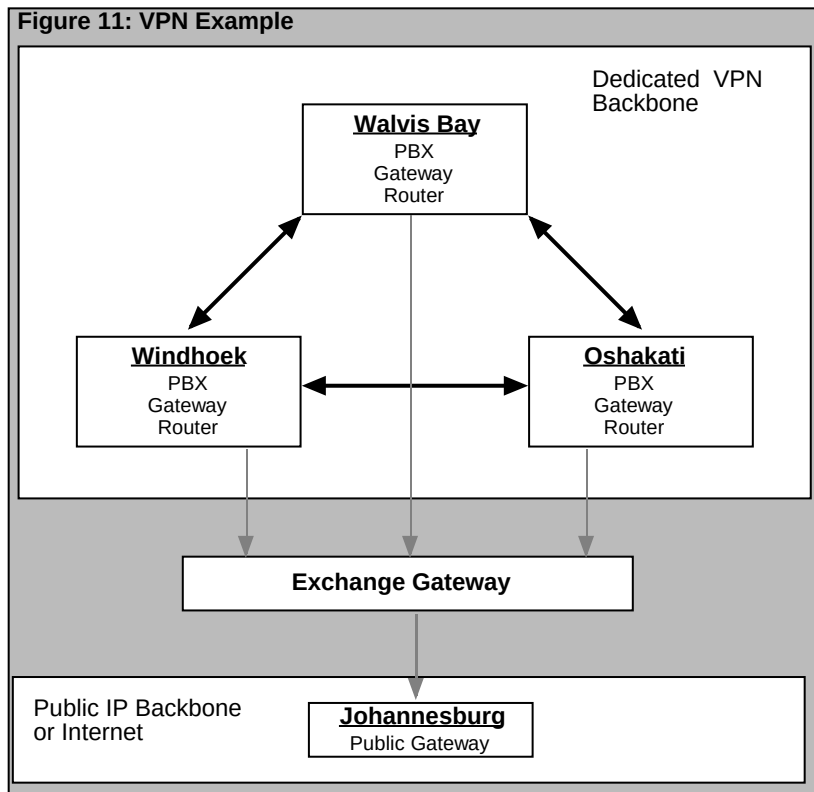


Table 1
Telecom Namibia data
(N\$ million)

	1993	1994	1995	1996	1997	1998	1999	2000
Revenue	225.5	221.1	273.9	330.60	373.40	454.5	588.02	652.40
Operating costs	158.4	168.3	235.4	259.6	290.4	368.5	460.9	552.2
Operating result	67.1	52.8	38.5	71.5	82.5	85.8	127.6	100.1
Net fixed assets	101.2	144.1	273.9	418	589.6	778.8	782.1	880
Net capital expenditure	28.6	71.5	158.4	178.2	223.3	270.6	127.6	249.7

Table 2
Employment and capital investments for Telecom Namibia

Year	Employment	Capital investments in N\$
1993	2,300	26,442,000
1994	2,050	69,604,000
1995	1,879	158,087,000
1996	1,689	177,907,000
1997	1,673	223,332,000
1998	1,818	271,205,000
1999	1,728	127,871,000
2000	1,667	249,982,000
2001	1,516	924,738,000

Table 3
MTC employment

Year	1996	1997	1998	1999	2000	2001
Employees	32	44	63	68	96	138

Table 4
The six biggest ISPs in Namibia

Name of firm	Year the firm first offered services	Owners of capital and their respective shares (domestic/foreign)
AfricaOnline	1996	100% foreign owned by AfricaOnline Holdings
Mweb Namibia	1996	100% foreign owned by MIH Holdings
Cyberhost	1996	100% foreign owned by AST
Iway	2000	100% domestically owned by NPTH
Infinitum	2000	100% domestically owned by NPTH
UUNet	1996	100% foreign owned by WorldCom

Table 5
Correlation coefficients for OECD countries

1st variable	2 nd variable	Correlation coefficient	T Statistic
Change in PC intensity per 100 inhabitants, 1992-99	Change in MFP growth corrected for hours worked, 1992-99	0.61	3.0
Internet hosts per capita, 1999	GDP per capita, 1999	0.66	4.48
PCs per 100 inhabitants, 1999	GDP per capita, 1999	0.83	7.45
Secure servers per million, March 2000	MFP acceleration 1980-90—1990-99 trend adjusted	0.54	2.57
Internet hosts per 1000 inhabitants, 1999	MFP acceleration 1980-90—1990-99 trend adjusted	0.63	3.27
No. of PCs per 100 inhabitants, 1999	MFP acceleration 1980-90—1990-99 trend adjusted	0.68	3.73
Average Internet access costs 1995-2000	MFP acceleration 1980-90—1990-99 trend adjusted	-0.54	-2.58
% ICT patents granted, 1998	MFP acceleration 1990-99 trend adjusted	0.56	2.69

Source: Pilat and Lee (2001).

Table 6
ADF test for unit roots

Variables	Test statistic	Critical values ^(a)		
		1 %	5%	10%
		Levels		
Real GDP	-2.930138	-4.0681	-3.1222	-2.7042
Real telecom investments	-1.571534	-4.0681	-3.1222	-2.7042
		First differences		
Real GDP	-4.059058	-4.1366	-3.1483	-2.7180
Real telecom investments	-3.437819	-4.1366	-3.1483	-2.7180

Note: ^(a) MacKinnon critical values for rejection of hypothesis of a unit root.

Table 7
Pairwise Granger causality tests

Direction of causality	F-value	P value of F	Decision
Tellnv causes GDP	0.14105	0.94377	Reject
GDP causes Tellnv	65.3933	0.09245	Do not reject

Table 8
Comparison of IP and circuit-switched networks

	Costs with:	
	Circuit-switched networks	IP network
Carriage of voice calls	Strong distance and duration dependent.	Weak distance and duration dependence.
Customer support	Staff intensive, either high cost or low level of support	Automated, therefore higher level of customer support for less costs.
Adding new services	High costs	Low costs
Dealing with growth in data traffic	Very high costs	Substantial but much less than for a circuit switched network
Data services	High because of the requirement to run separate overlay networks	Relatively low because all services (voice and data) run over a single network.
Human resources	Wage costs are high but not as high as for IP networks.	Requires highly skilled IT staff. Less staff than circuit switched networks since many tasks can be automated. But average wages will be higher.

Source: Sharma (2001a).

Table 9
Average monthly revenue breakdown for Telecom Namibia, 1999-2000

Revenue from:	Namibian dollars
Local calls	4,860,000
National calls	12,250,000
Cell phone calls	6,738,000
International calls	15,212,000
Total	39,060,000

Table 10
Telecom Namibia nominal prices during peak time

	Local	<100	<200	>200	South Africa
1-Oct-94	6	27	54	72	120
1-Oct-95	6	31	57	76	140
1-Oct-96	6	33	63	77	150
1-Oct-97	7.3	36	68	80	160
1-Oct-98	10	49	95	106	218
27-Nov-2000 (including VAT)	19	59	115	128	251

Table 11
Telecom Namibia real prices during peak time in 1994 prices

	Local calls	<100	<200	>200	RSA
1-Oct-94	5.50	24.77	49.54	66.06	110.09
1-Oct-95	5.05	26.09	47.98	63.97	117.84
1-Oct-96	4.63	25.48	48.65	59.46	115.83
1-Oct-97	5.17	25.50	48.17	56.67	113.35
1-Oct-98	6.50	31.85	61.74	68.89	141.69
27-Nov-2000 (including VAT)	10.39	32.28	62.91	70.02	137.31

Table 12
MTC nominal tariffs for professional subscribers

	Professional: Cell to cell		Professional: Cell to fixed	
	Peak	Off-peak	Peak	Off-peak
1995	1.36	0.88	1.36	0.88
1996	1.36	0.88	1.36	0.88
1997	1.36	0.88	1.36	0.88
1998	1.44	0.9	1.44	0.9
1999	1.08	0.75	1.57	0.98
2000	0.99	0.65	1.57	0.98
2001	1.14	0.75	1.81	1.13
2002	1.23	0.81	1.96	1.22

Table 13
Nominal tariffs for tango subscribers

	Tango: Cell to cell		Tango: Cell to fixed	
	Peak	Off-peak	Peak	Off-peak
1999	2.98	1.98	2.98	1.98
2000	2.24	0.98	2.98	1.98
2001	2.58	1.13	3.43	2.28
2002	2.58	1.13	3.43	2.28

Table 14
Price comparison for consumers in Namibia \$

3 minute peak call from Namibia to:	Telecom Namibia	MTC	Net2Phone
Tokyo	42.50	47.93	3.63
London	24.78	30.21	1.32
New York	37.17	42.6	3.3
Johannesburg	7.53	10.29, Cell to fixed 6.48, Cell to fixed	11.88

Note: 10 N\$ equals 1 US\$, April 2002.

Table 15
Number of computers for employment categories

No of employees:	Number of computers			
	0	1-5	6-25	26+
Between 1-10	37.19%	56.78%	6.03%	0.00%
Between 11-49	14.71%	58.82%	25.49%	0.98%
More than 50	6.45%	51.61%	19.35%	22.58%

Table 16
Number of computers for companies from specific sectors

Industrial sectors:	Number of computers			
	0	1-5	6-25	26+
Agriculture	36.36%	63.64%		
Manufacturing	56.52%	39.13%	4.35%	
Wholesale and retail trade	17.65%	59.66%	21.85%	0.84%
Tourism	14.29%	80.95%		4.76%
Financial services	5.0%	70.0%	20.0%	5.0%
Other services	43.42%	47.37%	9.21%	

Table 17
Number of computers with Internet access

No. of employees:	Number of computers			
	0	1-5	6-25	26+
Between 1-10	40.00%	58.40%	1.60%	0.00%
Between 11-49	33.33%	63.22%	2.30%	1.15%
More than 50+	11.11%	66.67%	7.41%	14.81%

Table 18
VPN 64kbit/s international link, three nodes plus Johannesburg

PSTN: Price per month (N\$)		IP network: Price per month (N\$)	
Digicon link x2	6,913.14	National Band width 64kbit/s x3	5,738.31
Digicon International half circuit	25,731.72	International Bandwidth 64kbit/ s x1	4,000
(The final price would be double since the South Africa based PSTN has to add their cost of the link as well.)			
Monthly total	32,644.86	Monthly total	9,738.31

Table 19
VPN 128kbt/s international link, three nodes plus Johannesburg

PSTN: Price per month (N\$)		IP network: Price per month (N\$)	
Digicon link x2	10,788.71	National bandwidth 128kbit/s x3	8,190
Digicon International half circuit	46,136.32	International bandwidth 128kbit/s x1	7,440
(The final price would be double since the South Africa-based PSTN has to add their cost of the link as well.)			
Monthly total	56,925.03	Monthly total	15,630

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