MUNICIPAL BROADBAND: THE 'NEXT GENERATION' AND THE 'LAST MILE'

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ABSTRACT: The article raises two related questions, the strategy question of whether South Africa should focus on universal access to the Internet in the next 10 years for all cities and towns and the operational question of how South Africa can migrate to a high-speed, high-bandwidth environment for all citizens and SMEs in the next 10 years. The diffusion of Internet access to South Africa's cities and towns has been slow and the diffusion of broadband even slower. A number of municipalities, mainly the large metropolitan areas, and a few smaller towns, have been developing models for 'municipal broadband' provisioning. The article responds to these two questions by reporting the findings of a series of interviews on municipal broadband in South Africa, comparing lessons from the US and ending with a set of four perspectives on future choices and approaches for municipalities. It argues that the metropolitan Governments surveyed have already embarked along the road of ubiquitous citizen access to the Internet through selecting 'digital cities' approaches. The challenge is to identify workable operational and financing models for municipal broadband across varying types of municipalities – metropolitan, smaller cities and towns. This is being digested in the learning experiments currently underway.

Broadband for the 'digital city'

Digital cities – can South Africa use "next generation" technologies to walk the "last mile"? The global technology shift towards digital communications, with many cities providing affordable broadband services to citizens for high-speed access to the Internet and thence to the multiplicity of public and private services available, raises the strategy question of whether South Africa should still be aiming for universal access to voice communications, or whether it is time to focus on universal voice services and universal access to the Internet in the next 10 years for all cities and towns. Digital cities come in many forms, as presented at the Kyoto meeting on Digital Cities held in 1999. These include arrangements whereby the city is reconstructed as a virtual city, an "electronic public space" where citizens and visitors can engage in interaction and transactions related to the city and its activities (Aurigi, 2000, pp. 33-44) or an infrastructure environment in which digital telecommunications and ubiquitous computing encourages greater mixing of urban living and work space to create "cities that are attractive, equitable and sustainable" (Mitchell, 2000, pp. 1-6). A related question is how South Africa can migrate to a high-speed, high-bandwidth environment for "power users" (businesses, academic and research institutions, schools, hospitals and clinics) and universal access to broadband for all citizens and SMEs in the next 10 years.

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Why are these important questions? South Africa has entered an era in which it has set itself targets to increase its global competitiveness positioning against other developing economies such as Brazil and India, while at the same time halving poverty and unemployment. It has chosen to do this, amongst other things, through investment in infrastructure (ASGISA, 2005). Given that South Africa is a small player among very large economies of the north and south, availability of the resources required to enhance its competitiveness and reduce its knowledge divides will play a very significant role in whether it succeeds or fails. This includes telecommunications and Internet infrastructure and other network infrastructures like energy.

In relation to global competitiveness, two points are relevant. One, business including small businesses, need to become Internet-based or e-businesses, with affordable high-speed access enabling them to participate in both local and global economic information and transactions chains. Two, South Africa needs to increase the numbers of people, especially young people who use high-speed Internet, as this provides access to valuable content for learning and development opportunities to enhance the knowledge base of its national human resource base. These components of the South African economy – advanced network infrastructures and a highly knowledgeable human-resource pool – are crucial factors for economic development.

Furthermore, the needs of citizens for a range of services, including health and educational services such as telemedicine or examination results, as well as ease of transactions with Government through electronic Government services, raises the bar for the provision of high-speed, high-bandwidth telecoms infrastructure and services. In the decade 1996–2006, multi-purpose community centres or MPCCs were created, but a major flaw was that they generally did not offer access to the Internet, hence residents in poor communities could not connect to the local or global world beyond their immediate geography. Community Internet access becomes valuable only if it provides a medium for local economic development and enhanced social interaction (Ishido & Isbister, 2000).

Universities and other research institutions require high bandwidth to process very large datasets and to work collaboratively with international networks of researchers. This, combined with the increasing demand from businesses and the general population for a range of Internet-based high-speed services, from shipping to shopping to schooling, provides a rationale for municipalities, metros and provinces, who are responsible for facilitating economic and social development, to consider facilitating public connectivity to high speed networks rather than merely

being consumers of telecoms services. This they can do through either a wholesale model where the municipality funds and builds the broadband facility and leases to private Internet service providers (ISPs), or a retail model where the municipality builds and operates broadband facilities and provides Internet, video and telephony services, itself becoming an ISP.

Across the world, cities are competing feverishly as attractors for business, for human capital, for revenue and thus information infrastructure becomes a crucial lever in growing the competitiveness of cities (Sassen, 2001). The City of Johannesburg and the City of Tshwane[2] in Gauteng, and the City of Cape Town in the Western Cape see themselves as such competitive global cities, so these considerations would certainly arise for them. The considerations also arise for smaller towns like Knysna, which hosts international business tourism and wish to address poverty and the infrastructure backlogs in the old townships and "locations". Business tourism has become a feature of South Africa's interconnection with global markets as business travellers, investors, academics and scientists complete their business in cities such as Johannesburg, Cape Town or Durban, adding three to five days to their itineraries to visit the country's tourism hotspots.

Rethinking the post-apartheid spatial landscape, many suburban areas and townships are plotting a new course for economic development. Amongst these, Soweto is re-creating itself as a "suburb" and is exploring ways of attracting people to live and work there. After 50 years of failure to invest in economic and social infrastructure in Soweto, the private sector has followed major investments made by residents and local Government in the last 10 years. This has resulted in multi-billion rand investments in property, roads and storm-water drainage and in the shopping malls that became hallmarks of the late twentieth century (Hlengani, 2007).

Soweto will host a number of the matches for the FIFA World Cup 2010 at the Soccer City complex, which will incorporate the International Broadcast Centre. The tournament will bring about 300 000 visitors to Johannesburg, where Soweto is located around 100 000 fans to each stadium and more than 100 000 fans, visitors, international journalists and local residents to entertainment venues throughout the city following each game event (City of Joburg, 2007). Soweto can take a significant share of this revenue if it is well-positioned. Thus, with a current population of more than a million people and a large number of schools, clinics and the Chris Hani Baragwanath hospital who could all benefit from high-speed Internet access; as well

2 Tshwane, which includes Pretoria, is a metropolitan municipality in the Gauteng Province and historically the administrative capital of South Africa.

as a growing tourist audience operating from bed and breakfast accommodation, sports, restaurants and music venues; widespread public and residential broadband accessibility could be a key attractor for citizens and tourists to make Soweto their residence of choice.

Municipal broadband provisioning could create the foundations for such access to fast Internet services – for major cities, for tourism hotspots, for "townships" entering the economic mainstream, and others.

Technology perspective

The term "broadband" commonly refers to high-speed, high-bandwidth Internet access. However it is defined, broadband implies transmitting at higher speeds than that common with a dial-up connection, typically more than 200kbit/s (FCC).

Broadband carries multiple signals (audio, data, and video) by dividing the total capacity of the medium into multiple, independent bandwidth channels, where each channel operates only on a specific range of frequencies. What this means is that broadband makes bandwidth "broader" and thus, able to transport more data. Thus broadband is not only a high-speed connection, but more importantly, it is a single-wire or wireless connection that increases a data transmitter's ability to carry several different frequencies at one time and enables "convergence", the integration or convergence of different forms of information to a common technology base via (in the case of fixed lines) a single cable. In practical terms, it means that email, documents, videos, movies, multi-media content can be loaded faster from the Internet either onto PCs or mobile phones (FCCs). In the US for example, convergence has allowed companies to offer "triple-play" solutions, ie telephone, Internet and TV via the same media, whether ADSL, DSL, fibre or cable. Municipal broadband is quite simply broadband services provided wholly or in part by municipalities or local Governments. The technology infrastructure could include a mix of Wi-Fi, higher bandwidth WiMax, line-of-sight and fibre optic technologies. The business model for the provision of these services could vary from self-provision to public-private partnerships, with different levels of opportunity for private sector competition.

Global trends: Why are municipalities getting involved in broadband provisioning?

Traditionally the role of local Governments has been critical in deploying the necessary infrastructure for communities to function as viable human and economic

entities. This includes the provisioning of municipal electric power systems, water and sewer reticulation, the maintenance of local roads and so on. Such services were and still are the requisites for the efficient functioning of settlements, whether rural towns and villages, cities or city regions. In the industrial age, these services enabled the transformation of natural resources into goods and services.

In the 21st century, information and knowledge economies require additional infrastructure, namely electronic infrastructure which embraces computers, data and the means to transmit the data. Broadband has therefore become a necessary utility not only for the delivery of traditional economic services, but also for commerce, education, entertainment and healthcare. In the current era, with the heightened role of urban entities as engines of economic growth and cultural activity, there is a worldwide trend for municipalities and local Governments to provide municipal broadband as a basic service to residents and businesses (Mitchell, *ibid*). In short, municipal broadband networks serve the digital infrastructure needs of cities and communities.

Local Governments need to provide broadband services designed to address community needs – health, education and welfare. By contrast, private companies work to maximise profit and while the profit motive often fosters innovation and deployment, it will leave vital community needs unmet unless local Governments step in to fill the gap.

Global cities and city regions, from Mumbai to Mexico, have exploited the accessibility and affordability of ICTs, multi-media and computer technologies to dramatically transform the structure and dynamics of their respective cities. They have further evolved the principles of good city design as espoused by authors such as Jane Jacobs (1961) – "healthy cities where people live, work, shop and play" and the idea of the "informational city" made explicit by Manuel Castells (1991) and applied ICTs to effect changes in urban governance, social outcomes and the social and cultural life of communities.

One perspective in this global trend is the development of "ubiquitous cities". The term "ubiquitous city" comes from Korea and Japan and denotes a vision for an urban future (Townsend, 2004) where people can conduct their work or social business efficiently, conveniently, safely from any place in the city, at any time of the day, because connectivity is widely available and affordable, electronic information and transactions services are accessible, and the range of services is constantly changing and growing. This is achieved through the deployment of mobile and/or wireless broadband technologies, operating off fibre-rich networks. The contributing ICT trends to

ubiquitous cities are: mobilisation of communications and computing, convergence of digital networks, convergence of locative media, mobile communications, GIS, and GPS/navigation and residential broadband penetration.

A study for the Province of Ontario, Canada, defined five critical success factors for the creation of Intelligent Communities (Intelligent Communities Forum). This list of "Intelligent Community Indicators," provides a conceptual framework for understanding the factors that determine a community's competitiveness in the "broadband economy" and include significant deployment of broadband communications to businesses, Government facilities and residences, with Government providing a catalyst when necessary through regulation, incentives and even network construction.

Taipei has worked to build a Cyber City, as the best way to enhance its competitiveness in the 21st century, taking steps including maximising the use of the Internet and minimising the use of roads for working, for networking amongst people and for interactions with the city Government, viewing Internet services as public utilities, thus making it as easy and convenient as using the telephone and television and creating a ubiquitous network of public services with modern fibre-optic technology as backbone infrastructure, and facilitated through public-private sector collaboration (Ying-jeou Ma, 2001).

In South Africa, the City of Joburg is preparing an enabling "digital skin" as the ICT platform for hosting a successful FIFA 2010 World Cup and exploring ways of utilising this infrastructure for legacy purposes (City of Joburg 2006). A digital skin encompasses the range of infrastructure and basic services required to enable 24-hour connectivity across a city, including a range of technologies, to ensure seamless communication which can form the basis for services including safety and security, entertainment and tourism and electronic Government. Municipal broadband provisioning is one element of this project, however the financial models and issues of supply and demand will need to be worked out (City of Joburg, 2007). The Blue Umbrella and B-Link programme of the Gauteng Provincial Government envisages provincial broadband provisioning as a means to facilitate higher quality of services in health and education, and more effective interaction across Government departments (Canca, 2007). Here too, demand and supply studies will be needed, but information is not yet available.

Municipal broadband in South Africa: solution to the digital divide or pipe dream?

Ironically, the possibility of local municipalities building their own broadband networks may never have come up in South Africa if it had not been for the excruciatingly slow pace at which broadband supply is growing (Esselaar, Gillwald & Stork, 2006, pp. 42 - 45) and the equally slow pace at which the telecoms regulatory environment is changing (Esselaar and Gillwald, 2007). According to Esselaar, *et al*, with only around 415 000 broadband subscribers in 2006 and limited competition among the five major service providers, despite a 100% growth rate in broadband subscriptions, South Africa lags behind other low- and middle-income countries. International approaches to increase broadband penetration have not yet been extensively tested in South Africa. This may be partly due to the fact that many of these approaches are proving difficult to sustain over time, with need for regular review and adaptation of the models. For example, public sector regional aggregation ie "bringing total broadband requirements of public sector customers in a given period into one procurement requirement to suppliers", as provided for in the UK Broadband Aggregation Project which proposed to significantly increase broadband availability (UK Broadband Task Force, 2003) and elsewhere, has seen a range of adaptations over the years since inception circa 2004, while commercial business models have failed to endure as discussed in the various examples from the US, see below. In this context and given the motivations discussed above, selected South African municipalities are either in the planning stages (Joburg and Cape Town), have deployed pilot projects (Tshwane) or have already rolled out municipal broadband networks (Knysna).

Technology and economics

One of the notable endeavours is the city of Knysna, where the municipal broadband network came about almost by accident (Easton, 2007). An IT audit revealed that the city had rolled out a wireless network that was illegal under the telecommunications legislation in force at that time. Knysna had been searching for a "hook" to move to the next stage of its growth as a city and so the idea of building a municipal broadband network for the city was born. Uninet won the bid[3].

Unfortunately, the Knysna broadband network is less than an unmitigated success. While the municipality has achieved its twin objectives of cutting its own costs and providing cheap broadband for the community, the network will only be available to

3 See Steve Esselaar and Pieter Soete Case Note (in this issue).

visitors and residents for as long as the city continues to support the network and foot the bill for network maintenance. The arrangement with the winning bidder, Uninet, was that it would finance and build the network, the cost of which was considerable because it involved setting up numerous Wi-Fi base stations in and around the city, connecting these to a city-wide communications backbone, establishing a call centre and an operations centre as well as employing 30 people. These implementation costs were to be offset by sales of data and voice over Internet Protocol (VoIP) services to the residents of Knysna (Vecchiatto, 2006). Uninet has since expanded its network to over 300 hotspots covering 90% of Knysna and the surrounding areas (Uninet, 2007). Unfortunately, the company has been less than successful in attracting customers to its premium services (Easton, 2007), because MWeb already covers the high income market. This may cause the company's enthusiasm for the project to diminish over time as it concentrates its efforts in more lucrative markets such as Cape Town and Mozambique, among others.

This reality suggests the need for a business model that takes account of local realities and adopts an explicit publicly-funded approach to make broadband services available to middle and low income communities, which could be feasible in a small town. However, it is highly questionable whether or not the model and technology can scale for a much larger city such as Tshwane (Kuun, 2007b).

The idea of municipal broadband appears to be sound, though its implementation has been fraught with difficulty. There is a suggestion that municipal broadband networks should be regarded as just another municipal service, that they should be free of charge at a basic level with the use of premium services such as higher bandwidth or prioritised traffic (for VoIP calls) sold by commercial service providers. The advantage of using this model is that the network itself is funded by the rates and taxes residents are already paying and, as such, there is already a cross-subsidisation mechanism built in (Easton, 2007).

With due attention to international lessons, the prevailing view among the technology managers interviewed is that the financial outlay for building network infrastructure in any of the major cities would be too large for any single commercial organisation to undertake. Due to the history of telecoms provisioning, there is also a resistance to the monopoly that such an arrangement would give rise to. Consequently, decisions have been taken in all the cities surveyed, for the municipalities to provide the basic underlying infrastructure.

The City of Tshwane where the municipality has laid more than 470km of fibre optic cable (Kuun, 2007a) with the objective of connecting schools, hospitals and clinics to

a broadband network and providing infrastructure for small, home offices and SMEs sees a number of challenges. Tshwane metro has opted for a business model which treats its broadband infrastructure much like it does its roads: it takes responsibility for building and maintaining the network, including the fibre, high-sites and wireless infrastructure, and invites commercial entities to make use of that infrastructure, by on-selling to residents. However, cracks may be appearing in this venture as My Broadband reported (November, 2007) that the free Wi-Fi Internet service sponsored by the City of Tshwane would terminate on 15 December 2007 as the Proof of Concept agreement between the City and the operator Neology came to an end.

City of Cape Town has approached the issue in a similar way to the Tshwane model. The City intends to build an optical-fibre network linking its own key buildings and other critical points. Once completed, it is envisaged that it will be in a position to lease spare capacity to licensed electronic communications service providers. This optic-fibre infrastructure is expected to take three to four years to install (Sooful, 2007). City of Joburg, on the other hand, plans to couple affluent areas with poor areas in a bid to spread the net, but this is unlikely to be workable because service levels in unprofitable areas are more than likely to drop over time.

The Last Mile

Fundamentally, the technology decision is about the so-called last mile – the link between individual homes or businesses and the area switches connected to the metropolitan network and thence the Internet. Many technologies have been tried and are being used to make that last mile connection.

In Johannesburg, for instance, 11 commercial organisations have been short-listed to set up and run pilot projects in designated areas of the city and its environs beginning in early 2008. The approach is a technology-agnostic one, under which the successful bidders will be free to choose the technology that best suits their infrastructure and budget (Naidoo, 2007). The technologies under consideration for these projects include Wi-Fi, WiMax and Broadband over Power Lines (BPL) and the intention is to use the pilots as an opportunity for the companies to prove both their chosen technologies and their business models (Naidoo, *ibid*). BPL technology is an interesting one because it has many apparent pros, though it is a very new technology which is relatively untried in large commercial implementations globally. The advantage is that power lines constitute existing infrastructure to the home and is already available to the majority of residences in the major cities.

A well-publicised pilot project conducted by Tshwane municipality and Goal Technology Solutions in the Rooiwal community north of the city was seen as highly successful. However, the subsequent commercial trial proved to be far less so. Two reasons for this latter failure appear to be public perception and lack of demand for high bandwidth links. In the first case it is asserted that people found it difficult to believe that they could use a power point for Internet access without getting an electric shock. In the second instance, demand is expected to change as bandwidth-intensive applications, such as Internet protocol television (IPTV), begin to make their appearance on the local scene (Kuun, 2007b).

There is one particular benefit to BPL technology that makes it attractive to the municipalities surveyed, namely that it allows them to read utility meters remotely and automatically, resulting in savings of millions of South African rand as a result of not having to use meter reading personnel. There would also be a dramatic reduction in the time between data capture and billing. On the negative side, however, there is a risk that BPL technology may prove to be a white elephant, because there is a compelling reason for the municipalities to deploy it, but no compelling reasons for the ISPs and service providers to invest in BPL. The end-user equipment over power lines is costly and those costs need to be amortised. However, the fundamental business benefit of being able to read meters remotely, and automatically, remains. It may be best to treat the technology as an entry-point for households into the connected world and build a model based on the premise that they will move on to other technologies as awareness of the alternatives increases. However, the continued power outages and failure by Eskom to meet the heightened demand for a continuous source of power may make the development of BPL inefficient and unattractive in the short term.

For the service providers, wireless is the most cost-effective approach, because they don't require a specific end-user device and wireless technologies enable the user to move around the home freely. As a last-mile technology, Wi-Fi is seen as unreliable because it is subject to electro-magnetic interference and there are serious questions about how much load it can carry before becoming unusable (Kuun, 2007b). Another possible solution is WiMax technology, which has been marketed almost out of sight, but like BPL, it is largely unproven at this stage. One option is to use WiMax from the base station to the home, then use Wi-Fi within the home and garden. Ultimately, however, the technology decisions will be driven by economics, the needs of the applications that consumers demand and the evolution of wireless and other next generation technologies.

As regards the technology choices, the Tshwane metro is alert to the technology limitations of Wi-Fi and, while it has piloted BPL, it has not taken a decision to utilise this technology to offer Internet connectivity to residences. The main reason here is that the metro does not currently see itself as a provider of last-mile connectivity. As regards the business model, the Tshwane metro has chosen to build only the backhaul infrastructure laying a fibre-optic bed in the city, thus telcos and ISPs can lease the infrastructure rather than laying out substantial capital investments. However, the issues of last-mile technology and connectivity will remain current within the sphere of the competitive ISP market for the foreseeable future, as the Tshwane metro does not at this stage have a last-mile strategy.

Lessons from the US: Business models that don't work

The Knysna business model emulates those used widely in much bigger cities in the US. Several of those projects have recently made the news for all the wrong reasons, most notably Chicago and San Francisco (Nuttal, 2007). Chicago, one of the most recent cities to curtail its citywide Wi-Fi project, was unable to implement a viable business plan with either AT&T or troubled Internet service provider Earthlink. After realising how much the build-out would cost, both companies tried to tweak the agreement terms and requested that Chicago become an 'anchor tenant', paying a guaranteed minimum fee to use the Wi-Fi network in support of city services. Chicago, like many other cities who have been asked to do the same, declined. (Gardiner, 2007). It has been assessed that a similar municipal Wi-Fi project in Provo, Utah, will not break even in the next five years, if then. The problem, it seems is that break-even point for the project is 50% of the city's 35 000 residences and current penetration is only 20% in the home market and a paltry 10% in the business sector (Walch, 2007).

There are other failures in the US including the cities of Cincinnati, Houston, Springfield and Louis; in most places plans have been put on hold while a solution is sought (Keen, 2007). Even the showcase city of Philadelphia, the first to moot a city-wide broadband network, has run into funding difficulties (Bangeman, 2007). This is important to note because it has been the example foremost in the minds of the designers responsible for formulating municipal broadband plans for Johannesburg. Another part of the economic problem lies on the demand side of the equation. While the basic idea of offering Internet access as a public service is sound, the problem is that US cities have not thought of the Internet as a form of public infrastructure that must be paid for – typically by tax dollars. Instead, cities have laboured under the

illusion that, somehow, everything could be built easily and for free by private parties. That illusion has run straight into the realities of infrastructure economics. The bottom line: city dwellers won't be able to get high-quality wireless Internet access for free. If they want it, collectively, they'll have to pay for it (Wu, 2007).

The primary point to note from the lessons of the US (and Knysna) is that the appropriate business model for municipal broadband in South Africa may not be a commercial model, but a public infrastructure model, which is funded through similar approaches to the funding of other bulk infrastructure such as water, roads and sanitation. Alternatively, a public-private partnership that uses a hybrid funding model of municipal infrastructure investment, incorporating long-term loans (20 years) from the development finance sector, combined with limited private investment for commercial returns could be designed.

However, there is a danger in this approach because municipalities may fool themselves into believing that the experience will be as routine as running water, gas and electricity systems. Before moving ahead with any such plans municipalities should consider seven factors: competition, performance competition, continuous improvements, technological, obsolescence, risk, and uncertainty (Ellig, 2006).

In all of the US cases quoted above, the technology chosen was Wi-Fi connected underground by kilometres of high-speed fibre-optic cabling. Technology limitations and cost along with basic economics conspired to cause failure. Specifically, when the big American telecoms companies were bidding for contracts, they often agreed to spectacularly generous terms. Many acquiesced to footing the entire bill for network build-out, maintenance and upgrades.

Then there is the issue of the radio transmitters needed to broadcast the signal. With a range of just 100 or 200 feet at most, Wi-Fi networks simply don't provide adequate access – especially for people in buildings or other enclosed areas. As a result, most networks deployed in the past several years have required between 20% and 100% more access points than budgeted (Gardiner, 2007). Furthermore, there are doubts whether Wi-Fi technology, in its mass market form, can support the fabled triple-play of data, voice and video that service providers and telecommunication companies see as a major revenue generator (Kewney, 2007). Recent developments in Wi-Fi technology indicate that it will, in time, be able to handle high-bandwidth applications. A technology called MediaFlex, has emerged that addresses this so well that triple play service providers in the US are queueing up to buy it (Kewney, 2007).

Most users of broadband, in both rich and poorer countries, still use broadband for much the same things that they used dialup for ie for e-mail and accessing web sites.

So how are the economic benefits realised? A study covering the US, Canada and Mexico, exploring how economic development professionals, business owners and managers view the economic benefits of municipal broadband revealed the following lessons (Settles, 2007):

- Focus on using the municipal wireless network to get residents to do more business locally and improve the economic well-being of existing businesses.
- Regardless of speed, access alone won't impact economic development without appropriate business recruitment campaigns, portals, content and applications, all of which local Governments should expect to facilitate either directly or indirectly.
- Economic development experts must be actively involved in the discussion before publicly presenting their vision for the network's impact in this area. They need a reality check.
- The economic development department, a local redevelopment agency or an entity should drive the economic development aspect of municipal broadband.
- Economic development teams must be thorough in assessing the need for, and the impact of, municipal broadband among business constituents in order to justify the costs.
- Business constituents should be surveyed about their needs/desires/expectations for a municipal broadband network.
- Prepare for home-based offices as the future of individual entrepreneurialism.

In short, in this as in other areas, it is important to pay close attention to the demand side of municipal broadband provisioning, in particular to the co-evolution of demand with supply. The concept of co-evolution is particularly important and necessary in the South African context, but it is apparent from the managers surveyed that the demand side (availability of new content and services on an increasing scale related to the identification of the top-priority needs of residents), has been given insufficient attention as compared to the supply-side issues of backhaul communications infrastructure.

Having said this, however, it is clear that broadband does create new opportunities that have potentially important implications in developing countries. More specifically, since broadband enables visually-rich video content, applications and services, and since the natural human way of communicating is visual and aural, this medium opens up the possibility of new development-related usages (Naidoo, Kaplan & Fransman, 2005).

The concept of digital cities or broadband cities is relatively new in the South African debates about ICT and development. Based on the initial review of incipient municipal broadband projects, it would appear that, from the point of view of economic and social strategies for development, these concepts can be applied to the large cities, namely the six metropolitan municipalities which include the Cities of Joburg, Tshwane and Cape Town and which incorporate large urban townships such as Soweto and Khayelitsha with large populations and high levels of service requirements for Government and private services. They may also be applied to and tested in some of the smaller high-income municipalities such as Knysna, which exhibit a requisite level of demand for high-bandwidth Internet services. Indeed these cities and towns are already striving to join the global trend of providing broadband infrastructure as an attractor to businesses and people to locate there, as well as ensuring connectivity for SMEs and residents and reducing the digital divide.

It is in this context that the question, whether South Africa should still be aiming for universal access to voice communications, as the current national policy stands, or whether it is time to focus on universal voice services and universal access to the Internet in the next 10 years for all cities and towns, should be debated as a matter of policy reform. A socio-economic development perspective as outlined above, suggests that a shift towards digital cities is a necessary step for such development. Indeed, the limited surveys conducted and reported in this paper, indicate that a few major South African cities have already taken this view and embarked upon strategic paths towards ubiquitous Internet access underpinned by municipal broadband provisioning. However, these are largely independent projects initiated to address market failure, rather than components of a national programme for increasing availability of broadband and hence fast access to Internet-based services, as a basis for ubiquitous electronic commerce and electronic Government.

The embryonic digital city strategic approaches in South Africa leave a number of questions unanswered, in particular what the appropriate last-mile strategies would be for each municipality and what lessons can be adopted and generalised from both the local and international contexts? A further question concerns the appropriate business models for municipal broadband provisioning – whether a private-sector fuelled commercial model, a public-sector fuelled utility model or a hybrid model as applied to different types of municipality – metro/city, transforming township, small

town? Analysis of demand across the entire spectrum of metropolitan areas, smaller cities and towns is crucial to formulating appropriate business models, which may differ based on demand and supply features and the financial and human resources of the particular municipalities.

Lessons from international experience regarding actions to increase broadband availability include a number of approaches that have worked in different measures. This is a dynamic field that is worthy of detailed study by South African policy-makers and municipalities and includes themes such as: aggregation of public sector provisioning; aggregation of consumer demand; building ubiquitous and mobile networks; public sector non-commercial business models versus commercial business models, to name a few. For South Africa, the overarching lesson is that initiatives to increase the supply of broadband are high risk and therefore well-researched common strategic frameworks for broadband supply, that address the varying needs of metro or city level Governments, transforming townships, or small towns, can reduce errors in judgement related to idealistic business models and inappropriate technology choices. Detailed feasibility studies will be needed to consider the application of international approaches, such as those listed above, to South African cities, townships and towns. A common strategic framework that addresses the critical issues framing digital cities, including business models for municipal broadband provisioning; technology choices and last-mile connectivity; content and services that foster co-evolution of demand; can be debated and formulated through the South African Cities Network, the umbrella network for the nine major cities. Such a framework could provide the basis for sharing lessons within the broader epistemic community and reducing the potential risk that each city faces on its own, as well as providing the basis for extracting lessons that can be applied to smaller cities, towns and municipalities. This would assist in preparing the way for a migration to digital cities where residents have real Internet connectivity and are therefore plugged in to the heartbeat of the local and global economy, rather than merely having infrastructure in the ground and in the air.

Secondly, a key lesson from the US is that "it's not about technology…", its about social purpose and local economic development. The lessons from the US suggest that demand for broadband is based on its value to users in generating additional opportunities or media for "doing business" and that analysis of user needs can provide a stronger basis for strategy design in relation to municipal broadband projects (Settles, 2007), with appropriate technology adoption based on needs, effectiveness and cost.

Thirdly, responding to the question of **how** South Africa can migrate to a high-speed, high-bandwidth environment, the research suggests that a public-sector based utility model, rather than a commercial model, would be appropriate at this stage of municipal or city development. Alternatively a hybrid model that combines on-balance-sheet funding with development financing and a private sector investment should be considered.

Fourthly, since building and maintenance costs are high and it can take time to recover the investment, cities and provinces, which are not motivated by profit but by promoting economic development through attracting citizens and businesses to their 'shores' see themselves as more effective providers of broadband than telecoms companies. Hence there may not be direct return on investment through high levels of subscriptions at commercial rates, instead the digital cities may increase their rates and tax base by having more businesses and residents locate there because of the attraction of broadband (and other digital services) availability which can be used as and when needed.

Finally, given the municipal broadband learning experiment currently in progress in South Africa's major cities, one possible solution would be to adopt the Cities of Tshwane and Cape Town models of deploying a city-wide fibre infrastructure and to sell the spare capacity to service providers. The income derived can then be used to finance the deployment of broadband services to areas that are not attractive to private enterprise.

Whatever the approach, strategies for municipal broadband provisioning will require a long-term political commitment and leadership, to ensure that the many obstacles that arise through the course of such an innovative venture are progressively resolved, and that the concept of a digital city for all income levels becomes a reality. ❑

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