Western Cape Government
Economic Development and Tourism

BETTER TOGETHER.

Connected Households

Western Cape Broadband Implementation Plan

Western Cape Government
Department of
Economic Development
and Tourism

Western Cape Government Broadband Implementation Plan

Connected Households

Confidential - do not distribute

The study was conducted on behalf of the
Department of Economic Development and Tourism by:

BMI TechKnowledge
Informing - Advising - Assisting

CONTENTS

CONNECTED HOUSEHOLDS

CONNECTED HOUSEHOLDS

REPORT ABSTRACT

The report summarises the final business case for the Western Cape Government (WCG) Department of Economic Development and Tourism (DEDAT) Connecting to the World broadband project let under tender EDT 004/11. This document describes the background to the project, summarises the 'As Is' situation and 'To Be' vision, builds on the findings from the primary research exercise and provides the justification and rationale for executing the Connecting to the World project.

The World Bank defines broadband as, "an interconnected, multi-layered ecosystem of high-capacity communications networks, services, applications and users … The ecosystem includes the networks that support high-speed data communication and the services these networks provide. It also includes the applications provided by these services and the users who are increasingly creating applications and content. Investments – by the public and private investors and agencies – and user demand expand the reach of high speed networks. These networks increase the availability of high-quality services to both users, and applications providers. Applications access these services to reach users, who respond to the affordability of these services and relevance of the applications. Users then grow in number and sophistication, demanding and driving greater investment in networks, creating the virtuous cycle for broadband."

1. Project background

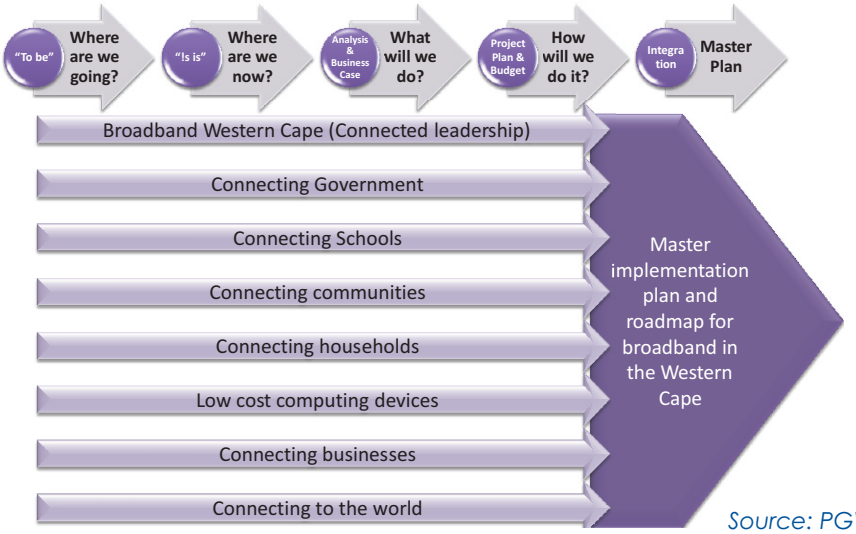
Overall programme

The WCG DEDAT, with the support of the Department of the Premier (DotP), has initiated a process to develop a provincial Broadband Strategy in consultation with a broad range of stakeholders: provincial, national and local government, the wider public sector (SOEs and agencies), private investors and the public.

As part of this process, a strategic framework was formulated to establish the parameters and the principles of the initiative within this transversal key priority areas and projects identified which are expected to impact significantly on the broadband landscape in the Western Cape, specifically relating to government service delivery, education and access of citizens, as well as economic development. Figure 1 shows the priority projects and the overall process flow that resulted from this process.

CONNECTED HOUSEHOLDS

Figure 1: WCG Priority projects identified



Source: PGWC, 2011

Process followed

For each work stream, a process was followed that included researching the future state based on local and international benchmarking ('To be'), assessing the current state ('As is'), identifying the gap between the two states and synthesising a way forward.

This report concerns the Connecting Households work stream.

Connecting Households

The WCG envisaged this project to cover two pilot sites to deploy a wireless mesh network in

1. an urban high density settlement in the metro; and
2. a smaller town in the Western Cape.

The project aims to:

- Create wireless mesh networks as a "last mile" open access network connecting all households in the selected communities. Pilots were to be conducted in the metropolitan area as well as in smaller towns.
- Further utilise the wireless mesh network for government-related initiatives such as:
  - Linking public safety and disaster management communications to this network e.g. Closed Circuit Television (CCTV), public warning systems.
  - Deploying smart meters.
- Seed the environment with low cost computing devices e.g. refurbished computers.
- Enable WiFi at schools, and provide selected secondary school learners with appropriate devices e.g. laptops.
- Make access to broadband services more affordable to recipient communications.
- Assess the viability of deploying wireless mesh networks as a mechanism to provide affordable access to broadband tele-

communications services to middle and low income households.

- Explore partnerships with the private sector to extend and/or maintain this network while ensuring "open access."

Objectives for the Connecting Households project

The WCG defined the following objectives for the Connecting Households project:

- All citizens in the targeted areas will have household access to the network.
- An increased number of citizens in the targeted nodes will have internet-connected computers in their homes (either their own or through the low cost computing project).
- An increased number of secondary school learners will have dedicated access to computing supporting the e-schools initiative.
- Positive impact on the indices relating to individuals having access to modern telecommunications infrastructure and computing devices in the Western Cape.
- All government facilities in the targeted nodes (schools, clinics, libraries, etc.) will also have access to the network.
- Improvement of public safety and disaster management readiness due to the easy deployment of CCTV cameras and public warning systems as a result of the network.
- Partnerships with the private sector to extend the network to other areas (private sector investment).

2. Connecting Households: 'To be' situation

South Africa is experiencing liberation in the telecommunications environment following what is seen to be a second wave of regulatory reform. Local and provincial governments are now entering the field of deploying communication technologies to stimulate socio-economic development. The initiatives of the cities of Tshwane, Johannesburg, eThekwini and Cape Town are well known, but smaller municipalities like Knysna have also made significant steps forward through the deployment of a wireless network.

The purpose of this project is to enable all citizens within the targeted nodes to have direct household access to the network and increased uptake of internet connectivity in the houses of citizens.

Wireless mesh technology background

Mesh networking is a way to route data, voice and instructions between points on the network known as nodes. In a mesh network, nodes are connected to one or several neighbouring nodes. This concept allows for continuous connections and reconfiguration around broken or blocked paths by 'hopping' from node to node until the destination is reached.

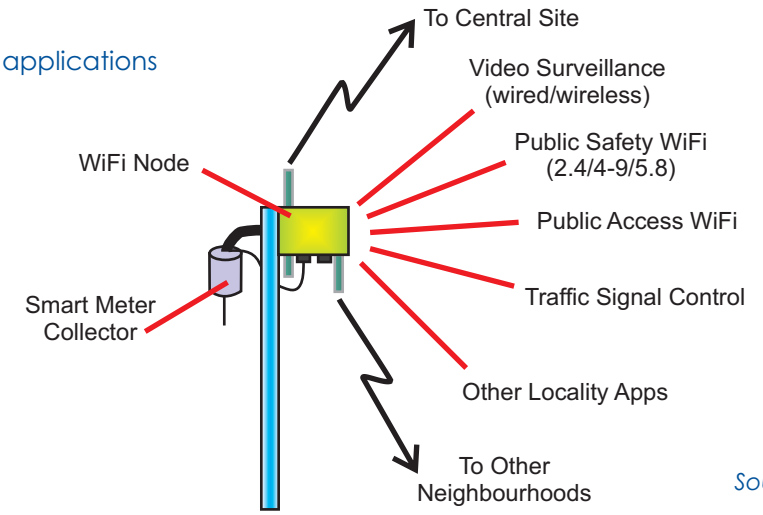
Consequently, mesh networks are self-healing: the network can still operate even when a node breaks down or a connection fails. As a result, a very reliable network can be formed and maintained. Mesh networking concepts are used in wireless and fixed (wired) networks. Wireless mesh was originally developed for military applications but has undergone significant evolution in the past decade or so and found widespread application in the commercial and public sectors.

Typical applications

Wireless mesh networks have found popularity with networks comprising several nodes (such as in an office environment), from small community services, right through to metropolitan scale networks, the latter being of particular interest to WCG. These wireless mesh networks provide long-range wireless data services, often over licence-exempt spectra, to public or private locations targeting the general public, enterprises and government offices, including public safety, utilities, etc.

Mesh networks may involve either fixed or mobile devices and the connection solutions are as diverse as communication needs. The best known applications are mainly found through public network access through desktop and laptop computers, smartphones and tablets. Wireless mesh can also be used in environments such as tunnels, on high speed mobile video applications on board public transport or real time racing car telemetry and are effective during emergency situations. Voice over Internet Protocol (VoIP) is a typical application that can be deployed fruitfully in a wireless mesh network, as was observed in a number of the case studies reviewed. By using a Quality of Service scheme, the wireless mesh may support local telephone calls that are routed through the mesh.

Figure 2: Wireless mesh applications



Source: Tropos, BMI-T, 2012

CONNECTED HOUSEHOLDS

Listed below are some outdoor wireless mesh applications that are relevant to local municipalities and other government departments:

- In-field access to municipal databases: case management, public safety, transportation, and public works.
- On-the-spot licensing, permitting and inspection reports.
- Parking enforcement: wireless enabled meters that send messages to parking enforcement personnel with personal digital assistants (PDAs) when vehicles are in violation.
- Outdoor access to a city-services portal, where citizens can report potholes, check event schedules, etc.
- Automated meter reading for water, and electricity.
- CCTV surveillance monitoring of high-crime areas.
- Fleet management: collecting engine telemetry data over the IP network and monitoring passenger loads.
- Mobile geographic information systems (GISs) for pinpointing the location of water mains, alerting firefighters to the presence of nearby chemical facilities, and more.
- Asset management through radio frequency ID (RFID) tracking.
- Voice over wireless Local Area Network (LAN).
- Wireless connectivity in schools and at students' homes, helping to bridge the digital divide.

Some wireless mesh networks support Location Based Services (LBS). This can be used to track the location of nominated client devices within the coverage area. LBS can also be used intelligently to give users access to information on resources in their immediate vicinity and, for example, details of the closest restaurant, store, library, police station, post office, etc.

Standards and spectrum requirements

Wireless mesh systems are based on the 802.11 family of products. 802.11 has evolved over the past 15 years and the 802.11n standard is considered the state-of-the-art. 802.11n is now commonly available and can be used for clients and infrastructure to deliver high levels of performance. All tablet computers on the market (Apple iPad, Samsung Galaxy, HTC Flyer, Huawei Ideos, et al) have 802.11n technology and it can be expected that all tablets in the future will utilise this technology. Likewise, most smartphones introduced to the market since early 2009 feature 802.11n capability and it is now in widespread application in wireless mesh infrastructure and in the client devices. The latter includes consumer devices such as internet cards and dongles for desktop personal computers (PCs), laptops, smartphones and tablet computers. 802.11n is also used in specialised devices such as smart meters and can be integrated into many devices such as parking meters, business management systems, security systems, etc.

CONNECTED HOUSEHOLDS

The radio spectrum used by wireless mesh systems is largely standardised across the world. In South Africa we follow the same standards as used in Europe. This means that our devices need to operate at lower power levels than in North American markets, therefore impacting on the performance of systems. Although a standard has been developed, wireless mesh systems use proprietary (vendor specific) mechanisms to connect the access points, which means that there is no interworking between systems.

Other considerations

Satellite is currently a very expensive and poor solution for broadband. Costs will come down with some new services, however, it has not been fully expanded upon in this report.

Case studies

There are many case studies for wireless mesh, both positive and negative. For the WCG project, our research has taken account of over 40 case studies of wireless mesh deployments. The wireless mesh networks (WMNs) deployed in the case studies under review mostly constituted communications networks made up of radio nodes organised in a mesh topology. The mesh clients were mostly laptops, cell phones and other wireless consumer devices, while the mesh routers forwarded traffic to and from the gateways which may, but need not have been, connected to the internet.

The case studies also illustrated how entire cities have deployed inexpensive, existing technology to bring connectivity to the city. Traditionally, most of these networks relied on a small number of wired access points or wireless hotspots to connect users. However, the later installations are all wireless mesh networks, where the network connection is spread out among dozens or even hundreds of wireless mesh nodes that "talk" to each other to share the network connection across a large area. When looking at cities currently proposing networks, the following goals were observed as a recurring theme:

- Improved worker productivity;
- Making the city more attractive to businesses;
- Bolstering the economy; and
- Bridging the digital divide or doing all of these things with one network.

Characteristics of wireless mesh networks

General performance

- For low costs and ease of installation, WiFi networks offer broadband performance of:
  - 11Mb/s to 54Mb/s with 5Mb/s to 20Mb/s of useful capacity per km^2
    - Some vendors even claim 35Mb/s over multiple hops;
  - Today's state-of-the art wireless LAN can achieve 300Mb/s using 802.11n with two spatial streams. Future developments will deliver three- and four-stream speeds of up to 600Mb/s. Standards are under development with these goals in mind.

- The cost of a WiFi network is proportional to the size and area covered, with some other factors that need to be considered:
  - Topography (shape of the earth's surface);
  - Number of clients (users) supported; and
  - Performance, which depends on the type of client systems used i.e. mix of older and newer devices versus newer devices only;
- Some meshed WiFi systems can support full mobility with handoff below the 50ms delay stipulated in the telecom world, this enabling mobility at speeds over 200km/h[1].

Advantages of meshed WiFi

The key benefits of meshed WiFi are as follows:

- Cheap, ubiquitous consumer data Common Platform Enumeration (CPE[2]) e.g. Personal Computer Memory Card International Association (PCMCIA) cards for laptops, USB thumb drives form factor devices for laptops and desktops, Personal Digital Assistants (PDAs), smart-phones and tablets.
- In effect these devices are getting cheaper as they are being increasingly integrated into cellular phones and other devices.
- Rapid deployment with simple, compact devices e.g. mount on lampposts.
- The network can be grown in an ad-hoc manner through ongoing placement of access points and gateways.
- Self-healing mesh improves system resilience and can reduce the number of single points of failure.
- Low power consumption per node.
- Directional antennae can be used to increase reach and coverage.
- The use of unlicensed Industrial, Scientific Medicall (SM) band spectra, hence reducing start-up costs (although some manufacturers offer models in the licensed bands).
- Voice-over Internet Protocol (VoIP)/ Voice over Wireless Local area network (VoWLAN) support for voice calls.

Disadvantages of meshed WiFi:

- The radii of cells are limited due to low powers per restrictions dictated by standards. The standards applicable in South Africa (and Europe) are different from those in the USA, and hence this is a significant factor when considering the benefits seen in North American case studies. The spacing between nodes is unlikely to be as generous as claimed by the vendors in their (North American biased) literature.
- Each cell requires its own power, which can be mains power or possibly an alternative energy source such as solar. When streetlights are used, the power must be

[1]. *Source: Derived from data from Strix, a network equipment vendor*

[2]. *Common Platform Enumeration is a structured naming scheme for IT systems, platforms and packages.*

available and not be centrally or locally switched during daylight hours. Alternatively, the system battery must be appropriately scaled to last for up to 15 hours of daylight (which is expensive and cumbersome).

- Bandwidth capacity decreases as more users are added. This is particularly evident if the same frequency band is used for access as well as for backhaul. The use of different radios for backhaul and access improves this situation.
- Mesh systems require multiple gateways to the internet. This is a function of the bandwidth offered to users and how they are spread about. There is a misconception that only a single gateway is needed for a large system. Access to the gateways via fibre or microwave point-to-point connections will need to be planned into the system.
- Unlicensed ISM band spectra may not be legally able to offer a consumer service, depending on the licence that the WCG chooses to hold. These services may need to be provided through a third party holding an Individual Electronic Communications Services (I-ECS) or perhaps Class Electronic Communications Services (C-ECS) licence[3].
- The WCG can expect little or no protection from the Regulatory Authority Independent Communications Authority of South Africa (ICASA) in the event of radio frequency interference. In other words, if other service providers or devices are transmitting offending signals, provided these are below the power levels detailed above, ICASA will do nothing to intervene.
- Possible interference from other Industrial, Scientific Medical (ISM) band devices e.g. microwave ovens, cordless phones, baby monitors, security devices, etc.
- Lack of relevant, standardised and implemented protocols to offer voice services with predictable, guaranteeable quality of service (QoS) and hence no service-level agreements (SLAs) can be offered.
- Security needs to be enforced and managed at all nodes. Since the user equipment is Commercial off-the-shelf (COTS), it is readily accessible to hackers.
- Time-bounded behaviour and latency becomes an issue when traffic must traverse several nodes. The latency involved in this relaying can affect time-bounded traffic, like voice or video. This problem is usually addressed via the routing protocols used to implement the mesh and through network planning and network design.
- The proprietary nature of the mesh protocols means that only one vendor's equipment

[3] *Individual and Class Electronic Communications Services Licences respectively. The former allows the holder to obtain numbers from the national numbering plan whereas the latter allows the holder to provide an electronic communications service that does not require numbers from the national numbering plan.*

can be used. This also reduces the purchasing power through the introduction of competition.

Possible uses of Wireless Mesh in the Western Cape

Following on from the above, the Western Cape can look to the following:

- Using wireless mesh to cover currently underserviced areas that will not be addressed by the private sector. This can extend from large areas such as the combined Mitchells Plain and Khayelitsha areas (total of around 75km^2), down to mid-sized towns such as Saldhana (around 10km^2) and even to providing single access points in facilities such as community centres (this option is a way towards providing universal access).
- Deploying wireless access points in existing government facilities to provide both outdoor and indoor services allowing citizens coming into the facility and within a certain radius to access the network.
- In all cases, the WCG can look to use the wireless facilities for both internal and external applications. Appropriate security approaches such as firewalls will be needed to ensure the separation of public and private data.
- Given the rising role of wireless and wireless mesh networks in data offload, the WCG can look to partner with the private sector. Different levels of funding may be required in different areas so as to entice the private sector to participate.

National targets and plans for Connecting Households

The National Broadband Policy published by the Department of Communications has a long term target of providing universal access to broadband services by 2019 and that household broadband penetration should be 15% by 2019. The Department of Communications is currently busy with a programme to refine this and other targets.

3. Connecting Households: 'As is' situation

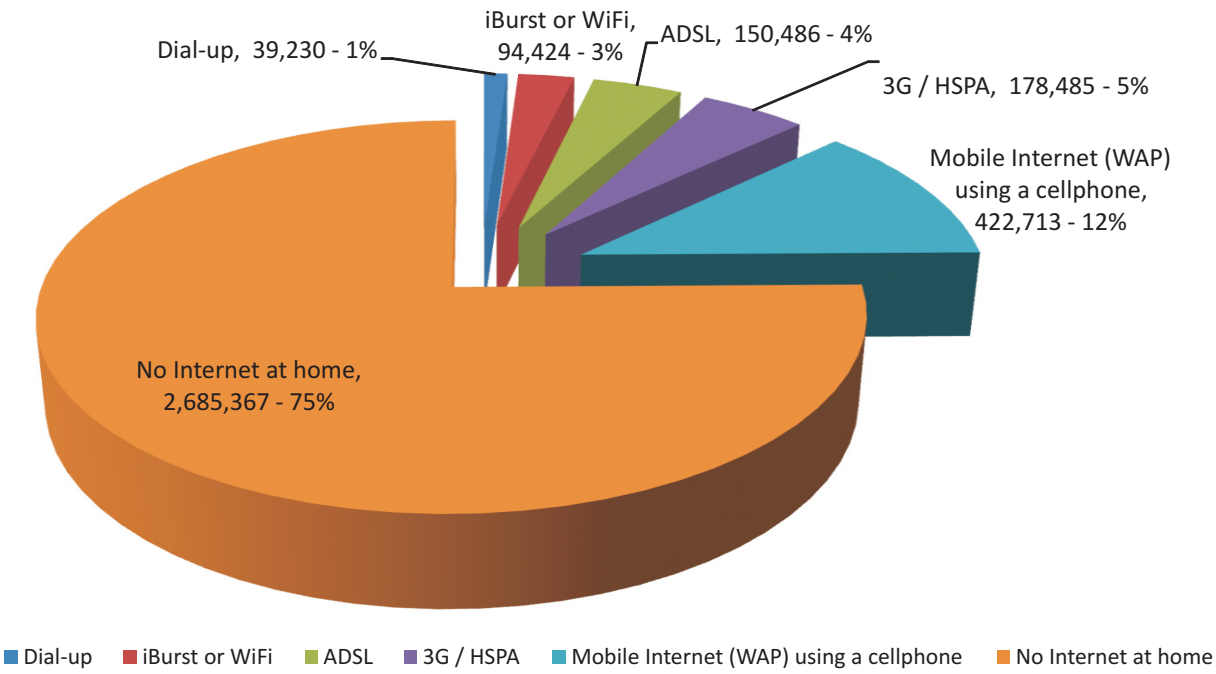
Current situation

Availability and affordability are still challenging barriers for households wanting broadband access. Although the Western Cape has the highest internet penetration of all nine of South Africa's provinces, it still has a very low penetration when compared to that of other nations. As can be seen from Figure 3 over 75% of individuals in the Western Cape do not have access to internet in their homes, and of those who have access a significant percentage are making use of their cell phones to connect to the internet[4].

[4] *Source: AAMPS, 2010*

CONNECTED HOUSEHOLDS

Figure 3: Western Cape Individual Internet at home , by access method, 2010

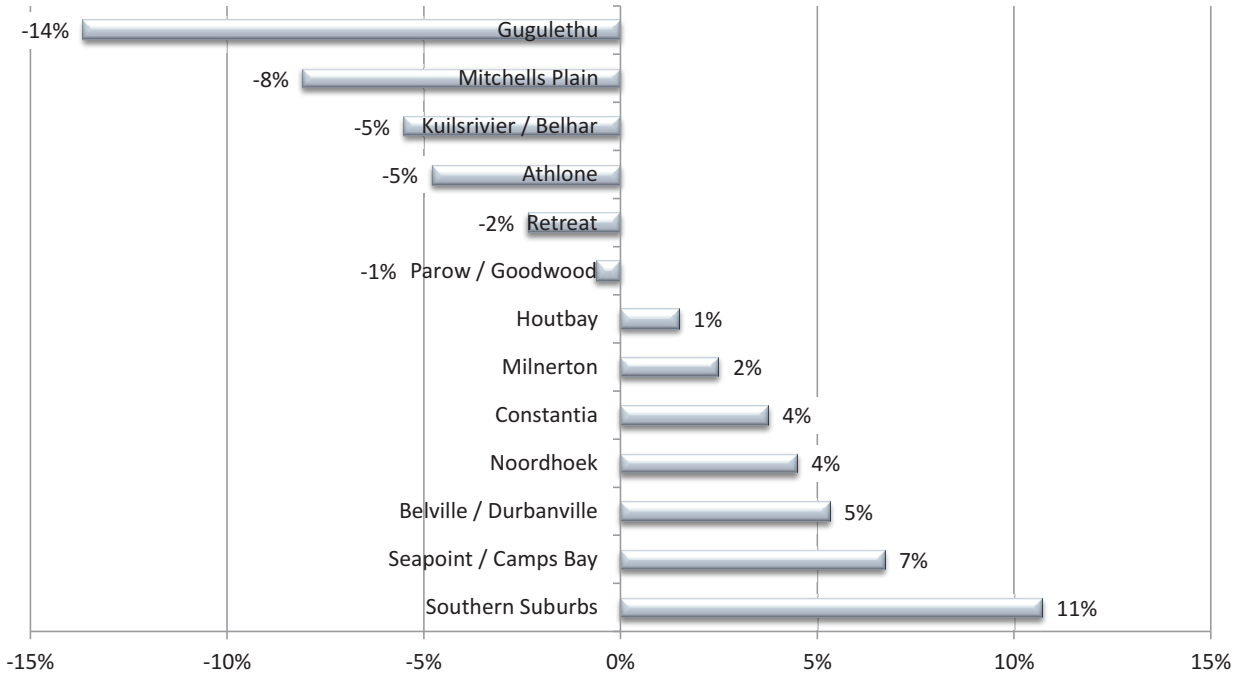


Source: AMPS 2010 survey, 2010, BMI-T, 2012

Figure 4 shows that within Cape Town and its surroundings areas, the penetration and distribution of household internet varies greatly. Gugulethu and Mitchells Plain have the highest number of households, yet they are the most underserviced internet areas, whereas the Southern Suburbs has the highest penetration and distribution of internet.

CONNECTED HOUSEHOLDS

Figure 4: Relative household Internet gap or surplus in Internet distribution[5] in the City of Cape Town (CoCT) Cape Metropolitan area



Source: ROOTS 2010 survey, 2010, BMI-T, 2012

(No data is available for the Khayelitsha area and hence it is not shown here. What is clear is that Mitchells Plain and Gugulethu fall well behind in the ratings)

Economic forces and principles dictate that the private sector telecommunications companies will target the more lucrative areas at the expense of the less attractive areas. The latter is likely to be any of those below the 0% threshold shown in Figure 4 above. Many of the smaller towns and outlying areas of the larger towns will find themselves falling into this category. It therefore makes sense to target these areas with government intervention because the access gaps will not be closed merely by market forces.

The WCG has the medium term goal (by 2020) that every citizen in every town and village will have access to affordable broadband

[5] *The chart takes each area, works it out as a % of the total households, in other words, how many are in that area (e.g. Belville accounts for a little over 10% of the households in Cape Town). It then looks at the number of homes that are connected to the Internet per area (e.g. Belville accounts for nearly 16% of the Internet connections). The 'Internet Surplus or Gap' is the difference between these figures, so around +6% in the case of Belville. Taking Mitchells Plain on the other hand, it accounts for 11% of the households but only 3% are connected, so the gap is -8%.*

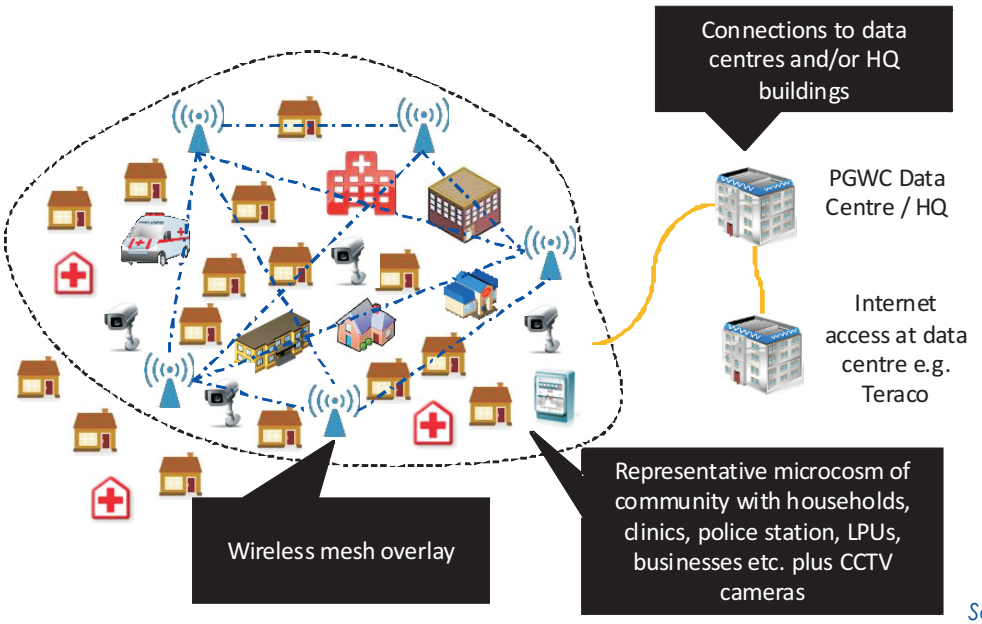
infrastructure, while citizens in the metropolitan area will have access to affordable broadband infrastructure at network speeds in excess of 100Mbps. Wireless and wireless mesh systems can find a role in most towns in the Western Cape as the data rates and coverage afforded by wireless mesh make this a viable proposition.

Desirable characteristics of a wireless mesh pilot project

The density of (potential) users will determine the viability of any scheme, and as with any engineering decision, wireless mesh can be considered along with other access schemes. Wireless has the advantage of being able to serve a relatively widespread customer base at relatively low cost. Moreover, similar equipment can be used in a meshed configuration to serve a wider area and/or density of subscribers. Figure 5 provides a view of a typical wireless mesh pilot. The following characteristics can be identified in the diagram:

- Bounded area
- Coverage of different client types in both the public and private sector
- Client devices of interest to different Government departments
- Different levels of demand on the system from low-end housing to high-end CCTV streaming video
- Backhaul connectivity to the client's data centre
- Access to the internet for both local and international content

Figure 5: Simplified view of ideal wireless mesh pilot site



Source: BMI-T, 2012

CONNECTED HOUSEHOLDS

Mitchells Plain and Khayelitsha

The combined populated area of these two areas is around 72km^2 [6]. Statistics show that the population is over 1,000,000 people. Figure 6 provides a graphical view of the combined area. Notable characteristics are:

- 3 large hospitals (large red crosses)
- 15 clinics (smaller red crosses)
- 4 police stations (police man icon)
- Many schools (blue dots)
- Many government-owned properties (yellow dots)
- Shopping malls and a variety of housing types
- Street lighting poles for mounting of devices
- Some existing wireless services (sources of interference)

Figure 6: Mitchells Plain and Khayelithsa areas

Source: BMI-T, 2012

Table 1 shows how the characteristics of the Mitchells Plain and Khayelitsha areas mapped against the desired characteristics identified earlier.

[6] *The exact area depends on whether or not open spaces are factored into the calculations, plus some uncertainty of fringe areas. Nevertheless, the area is in the range to 70 to 75km^2.*

CONNECTED HOUSEHOLDS

Table 1: Mapping of Mitchells Plain and Khayelithsa areas against desired characteristics

Characteristic	Attributes
Population coverage	These areas are densely populated with a combined population of over 1 million persons.
Demographics	There is a wide mix of Living Standards Measure (LSM) 1 to 6 (or even higher) households in the target area.
Boundaries	The areas are quite well defined. The coastal border to the South, N2 to the North and natural borders to the East delimit the area.
Topography	The area is largely flat. This increases the chances of interference. The ability to test wireless in rugged terrain will not be experienced in this pilot.
Scatter and clutter	There are many different types of property and structure in the area, ranging from shopping malls and double storey buildings to shacks. The use of tin roofs makes for a challenging environment for radio frequency signals.
Power	Mains power is available. This is supplied by the CoCT in Mitchells Plain and by Eskom in Khayelitsha, which will add a level of complexity to the deployment.
Mounting options	The presence of different lighting structures and government facilities means that several mounting options are available and will need to be explored.
Backhaul	The CoCT optical fibre for backhaul to be built in Phase 2 (expected in 2012) runs through the area. This is shown as a pink line in Figure 6. CoCT also has a radio mast in the area.
Client devices	As evident in Figure 6, there are many potential client devices. These are schools (blue dots), government facilities (yellow dots and white squares), clinics (small red crosses), hospitals (large red crosses) and police stations (policeman icon). Through the *Low Cost Computing Devices*, there is the potential to seed the area with many low-cost devices. Through an interview undertaken in the *Connected Government* process, the data has shown that some 30 000 students live in the area, who attend the University of Stellenbosch, University of Western Cape and University of Cape Town, as well as the Further Education and Training Colleges in the area. They would greatly benefit from the service.
Commercial	The area is served with 3G/HSPA services from Vodacom, MTN, Cell C and 8ta (Telkom) plus WISPs such as Amobia and Kawuleza Connect. Affordability is a key issue and the wireless mesh may lower the cost of entry for commercial services.

Source: BMI-T,

Characteristic	Attributes
Under-served area	Based on coverage plots from the operators above, coverage does not seem to be uniform. Telkom has exchanges located in Mitchells Plain and Khayelitsha. Based on feedback from the interviews and checking against Telkom numbers, Diginet and ADSL services are available in these areas although copper theft is recognised as a problem and service interruptions are frequent. A reliable wireless service would prove to be an acceptable alternative.
Regulations	The area falls within the CoCT metropolis. The Cel Private Electronic Communications Networks (P-ECNS) telecommunications licence covers the area and may be used.
Spectrum Interference	Industrial, Scientific Medical (ISM) spectrum is available across South Africa. Given the density of the area and possibility of existing services, it can be assumed that the background noise level will be high.

Saldanha

Saldanha is a small town located at Saldanha Bay. As is evident in Figure 7 , the area is bounded to the West and the East by water, and there is open ground to the North and South. The identified area is around 5km^2 which makes for an excellent initial pilot programme.

Figure 7: Saldanha Bay area

Source: BMI-T, 2012

As above, the characteristics of the area are shown against the identified criteria.

Table 2: Mapping of Saldanha area against desired characteristics

Characteristic	Attributes
Population coverage	The population of the Saldanha Bay Local Municipality is around 80,000. On the assumption that around 20% of the population live in the targeted area, this puts the population within the designated area at roughly 16,000.
Demographics	The target included a mix of households including an area of Living Standards Measure (LSM) 1-3 and other areas of LSM4-6. Unemployment is known to be high and the area is ripe for economic development.
Boundaries	The area is well bounded by natural features.
Topography	The area has a few hills that will impact on radio propagation.
Scatter & clutter	There is a mix of building types in the area.
Power	Street lighting is present. Alternative energy sources can also be investigated.
Mounting options	A variety of mounting options were observed including lighting structures at the sports field, radio towers, street poles and others.
Backhaul	Telkom services are available in Saldanha. Wireless backhaul could be provided to the Broadband Infraco site at the Eskom Aurora substation, some 30km to the East of Saldanha.
Client devices	The area does not have many services. There are six schools in the area, one clinic, one community centre, one SAPS police station, a Social Development facility, a Department of Public Works and Transport (DoPW&T) and a Motor Vehicle Registration facility.
Commercial interest	There is some existing coverage in the area. Trusc is a service provider operating out of the Vredendal area.
Underserved area	Based on coverage plots on the operators' websites, it is noted that there are 3G/HSPA services available in Saldanha. Vodacom, MTN and 8ta offer service while Cell C is a roaming service on Vodacom's EDGE network. WISPs Trusc, Comtel and Paarl Online claim that services are available in the area.
Regulations	The Cel P-ECNS telecommunications licence covers the area and can be used.
Spectrum	ISM spectrum is available across South Africa.
Interference	Given the density of the area and possibility of existing services, it can be assumed that the background noise level will be low. The presence of water and the Atlantic climate (mist, etc.) will have a bearing on the radio propagation.

Source: BMI-T, 2012

Wireless Mesh Access Business Model

The proposed business model for the PGWC trials is the Exchange Management Open Access Model (ExMOA). The network is built on the principles of 'open access,' allowing the client to access the network and to choose any service provider based on criteria of importance to the client. The client is then subject to the charges of the chosen Internet Service Provider (ISP), which can vary from one to the other. This model is well suited for large scale rollouts such as Mitchells Plain, Khayelitsha and Saldanha Bay.

Exchange Management Open Access model

In the ExMOA model, connectivity options for clients are enhanced by providing the client with a choice of different ISPs thereby giving them the opportunity of choosing a product that best suits their needs.

The important role players in this model are:

- the infrastructure provider, which in this case would be the WCG, acting as the project sponsor;
- the Network Exchange Management operator, selected through a bidding process. This party is likely to be an existing Internet Service Provider (ISP) or could be the Special Purpose Vehicle (SPV) conceived in the *Connecting Government* project; and
- the service provider organisations, or ISPs. Again, the SPV could be one of the participants at this level.

The general concept is possibly one of Build, Operate and Transfer (BOT) which would see the WCG funding the building of the network and providing a concession to the Exchange Management operator (ExMO). Royalties would be paid to the WCG and are estimated later in this business case.

Network access process

Once the client's WiFi device (conforming to 802.11a,b,g or n standards) has picked up the WiFi signals, it establishes wireless connection and the user is presented with a login or electronic sign-up form to gain access to the network. This form of access will allow pre-paid or contract based access and a number of service providers and their products will be listed. The user logs onto the service provider of choice and services are then provided as requested.

4. Financial implications

Cost estimate for Khayelitsha and Mitchells Plain Pilot

The cost of a WiFi network is proportional to the size and area covered with some other factors that need to be considered such as the topography (shape of the earth's surface), number of clients (users) supported, backhaul options and expected performance. For this project, security blanket coverage of the area with multi-client support (802.11b/g/n), 70 Mb/s network throughputs, no single point of failure and a cellular network plan are the ideal features of a potential network.

CONNECTED HOUSEHOLDS

Using benchmarked deployment figures and based on knowledge of the area, the original estimate of R22.8m Capital Expenditure (CAPEX) was determined for Khayelitsha and Mitchells Plain. Allowing for contingencies, an overall figure of R23.0m is an acceptable estimate. In terms of Operation Expenditure (OPEX), using the ExMOA model, and because this is effectively a BOT arrangement, there is no OPEX to the PGWC. The model would need to be very successful to have a positive Net Present Value (NPV) and current projections show the pilot for Khayelitsha and Mitchells Plain being marginally profitable in Year 5 with an NPV of -R1.0m.

Note: this amount has been adjusted taking into account the economies of scale in the overall Master Plan.

Cost estimate for Saldanha Pilot

Using the same approach as above, the overall cost for the Saldanha Bay pilot and allowing room for contingencies, the CAPEX requirements for the Saldhana Bay pilot is of the order of R9.0m. For Saldhana, the costs are lower but overheads remain high yielding a 5 year NPV of -R46k.

Project funding

The level and type of investment is such that it could be funded through an interest free grant from the WCG. There will be no further support provided. The project will be deployed very quickly (in under 12 months) and no roll over of capital is expected. Alternatively, the project would be wrapped up into the SPV proposed for the Connecting Government project. The financing for this approach is in the Connecting Government report.

As seen from the deployment information, the R32.0m would be spent within a year.

Economic rationale

Background

Strategic Economic Solutions (SES) was appointed to undertake the economic evaluation of the Connecting Government, Connecting Households and Connecting to the World projects. The analysis period incorporated all the costs over a 20 year period[7] and values were discounted to present day values by using a social discount rate of 8%. This corresponds to the rate prescribed by the South African National Treasury and the Provincial Department of Transport of the Western Cape Government. The cost benefit analysis was developed based on best practice and in consultation with the guidelines of the Manual for Cost Benefit Analysis in South Africa. Although all the costs and the benefits are concentrated within the Western Cape the analysis has been conducted from a country wide perspective.

[7] *The figure of 20 years applies to the Connecting Government project while 5 years was used for the Connecting Households and 10 years for Connecting to the World project as these two projects have a different profile in terms of technology lifespans.*

CONNECTED HOUSEHOLDS

The outcome of the analysis shows a net present value (NPV), a benefit cost ratio (BCR) and an internal rate of return (IRR) for those cases where the project is compared to a do minimum alternative (in this case "do nothing"). The NPV shows the total value of future costs and benefits reduced to a present day value. The BCR measures the changes in benefits and costs that would result from an investment. BCRs are typically used when there are many competing alternatives and projects need to be funded from a limited set of resources. Finally, the IRR is the discount rate that returns a NPV of zero and shows the likely economic returns to society of a project in relation to other investment opportunities.

An economic analysis also includes all costs to society, which is done by adjusting for shadow prices and wages and removing the distortions caused by taxes and subsidies.

Outcomes

The results of the cost benefit analysis of Project 2 are presented in Table 3 below.

Table 3: Connecting Households Cost Benefit Analysis (Rm)

Parameter	Mitchells Plain & Khayelitsha	Saldhana Bay
Costs		
Capital costs	R19.0	R7.5
Operating costs	R7.0	R3.1
Computer costs	R82.5	R4.4
Total costs	R108.4	R15.0
Benefits		
Economic growth	R1 533.7	R98.5
Total benefits	R1 533.7	R98.5
Economic results		
NPV	R1 425.2	83.5
BCR	14.4	6.6
IRR	1004%	197%

Source: BMI-T / SES, 2012

The Computer costs are not for the account of the pilot programmes.

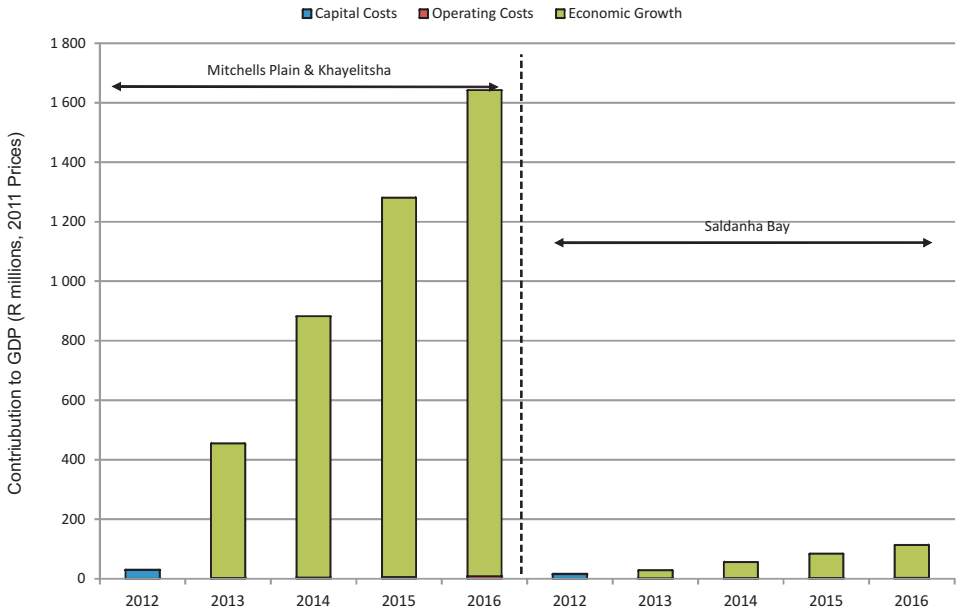
The BCRs for both parts of this project suggest that it is economically robust and should be pursued. It should, however, be noted that the key to success of this project is ensuring that families purchase

computers. Without this the project would fail. For these projects to breakeven (i.e. have a BCR of 1) Mitchells Plain and Khayelitsha require a penetration rate of 8.7% (currently 5.6%) and Saldanha a penetration rate of 17.6% (currently 12.0%). Strategies would need to be put in place to ensure that these penetration rates are achieved and exceeded. Such strategies might include adult education programmes, advertising in local schools and the bulk purchase of entry level computers to help make them more affordable to these communities.

Gross Domestic Product

For Mitchells Plain and Khayelitsha the overall contribution to Gross Domestic Product (GDP) is expected to total R31m in 2012 from capital and operating expenditure. Thereafter it increases to R490m in 2013 and R1 678m in 2016. The dramatic increase is based on the fact that in 2013, the network will be operational and significant increase in computer devices will occur. For Saldanha Bay the total contribution to GDP amounts to R16m in 2012 and then increases to R30m in 2013 and R115m by 2016. Economic growth due to increased household penetration is more marked for Mitchells Plain and Khayelitsha because of its higher and denser population. This contribution amounts to R452m in 2013 and increases to R1 634m in 2016. The contribution for Saldanha Bay equates to R27m in 2013 and increases to R111m in 2016.[8]

Figure 8: Connecting Households: Detailed Contribution to GDP



Source: BMI-T, 2012

[8] *In 2012 the equipment is deployed (the contribution to the GDP is the CAPEX). From 2013, the network is operational and creating usage and income. There is also (assumed) expenditure on PCs and access devices.*

Direct and Indirect Job Creation

Although the direct job creation impact of the projects is relatively small, increased economic growth would result in many more indirect jobs being created. Table 4 shows the estimated number of jobs created, both direct and indirect.

Table 4: Estimated number of direct and indirect jobs to be created.

	2012	2013	2014	2015	2016
Mitchells Plain and Khayelitsha	83	1 205	2 265	3 251	4 144
Saldanha Bay	39	73	142	212	283

5. Environmental Analysis

Wireless mesh devices are typically mounted on the sides of buildings or on street poles. Figure 9 shows several examples of the devices. Each manufacturer has their own form factor, but the units are generally around 5 litres in volume with a number of external antennae. All are "high tech" and quite aesthetically pleasing. Mounting on street poles has several advantages, namely, the poles are usually conveniently spaced, are at a good height (for wireless propagation and safety and security reasons) and are mains powered.

Figure 9: Examples of meshed WiFi access points

Source: BMI-T, 2012

From left to right: Tropos, Motorola, Neology (RSA) and Strix. Note these are all mounted on lampposts.

Permission will, however, need to be sought from the relevant government department for mounting the devices. Interaction with the Department of Environment Affairs and Planning has shown that no Environmental Impact Assessment appears to be necessary to mount these devices.

CONNECTED HOUSEHOLDS

Acronyms

ALC	Adult Learning Centre
ABET	Adult Basic Education and Training
ADSL	Asymmetrical Digital Subscriber Line
ALC	Adult Learning Centre
APP	Annual Performance Plan
AP SWAN	Andhra Pradesh State Wide Area Network
ARRA	American Reinvestment and Recovery Act
BCR	Benefit Cost Ratio
BOT	Build, Operate and Transfer
BPO	Broadband Project Office
C-ECS	Class Electronic Communications Services
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CBD	Central Business District
CCTV	Closed Circuit Television
CEI	Centre for e-Innovation
CHIPAC	Telkom's Customer-Half IP Access Circuit
CIO	Chief Information Officer
CINX	Cape Town Internet Exchange
CLC	Community Learning Centre
CoCT	City of Cape Town
COTS	Commercial off-the-shelf
CPE	Common Platform Enumeration
CSC	Common Services Centre
CTICC	Cape Town International Convention Centre
DBSA	Development Bank of Southern Africa
DCAS	Department of Cultural Affairs and Sport
DEDAT	Department of Economic Development and Tourism
DFA	Dark Fibre Africa
DGITO	Departmental Government Information Officer
DHQ	District Headquarters
DOC	Department of Communications
DOH	Department of Health
DOPW&T	Department of Public Works and Transport
DoT&PW	Department of Transport and Public Works
DotP	Department of the Premier
DPE	Department of Public Enterprise
EASSy	EASSy is a 10,000km submarine fibre-optic cable system deployed along the east and south coast of Africa to service the voice, data, video and internet needs of the region.
ECA	Electronic Communications Act
ECNS	Electronic Communication Network Services
ECS	Electronic Communications Services
EIA	Environmental Impact Assessment
EPWP	Expanded Public Works Programme
ExMO	Exchange Management Operator
ExMOA	Exchange Management Open Access

FET	Further Education and Training
FTTH	Fibre to the Home
FTTH	Fibre to the Premises
GB	Gigabytes = 1000 Megabytes
GB/s	Gigabytes per second
GCIS	Government Communication Information Systems
GDP	Gross Domestic Product
GEN3	Generation 3
Ghz	Gigahertz
GIS	Geographic Information Services
GSi	Government Secure Intranet
HEI	Higher Education Institution
HSPA	High Speed Packet Access
I-ECS	Individual Electronic Communications Services
ICASA	Independent Communications Authority of South Africa
ICT	Information and Communication Technologies
IDA	Infocomm Development Authority
IDC	International Development Collaborative
IEC	Independent Electoral Commission
INR	International normalized ratio
IP	internet provider or internet protocol
IPStream	IPstream is the most highly-used wholesale broadband Internet service
IRR	International Rate of Return
IRU	Indefeasible Right of Use
IS&T	Information Services and Technology
ISAD	Information Society and Development
ISM	Industrial, Scientific Medical
ISP	Internet Service Provider
ISRD	Integrated Sustainable Rural Development
IT	Information Technology
ITU	International Telecommunication Union
Kbs	Kilobytes
Kbps	Kilobytes per second
LAN	Local Area Network
LBS	Location Based Services
LCD	Liquid Crystal Display
LLU	Local Loop Unbundling
LSM	Living Standards Measure
LTE	Long Term Evolution
MB	Megabytes = 1 000 kilobytes
Mb/s	Megabytes per second
MFMA	Municipal Finance Management Act
MFN	Multi-frequency Network
MHQ	Mandal Headquarters
MIU	Mobile Internet Unit
MOF	Microsoft operations framework
MOF	Ministry of Finance
MoU	Memorandum of Understanding
MPLS	Multi-protocol Label Switching
MS	Microsoft

MTEF	Medium term expenditure framework
NBN	Nationwide Broadband Network
NBWM	National Broadband Wireless Network
NGO	Non-governmental Organisation
NHS	National Health Service
NPO	Non-profit Organisation
NOC	Network Operation Centre
NRI	Network Readiness Index
NPV	Net Present Value
NU	Network User
OECD	Organisation for Economic Co-operation and Development
OPEX	Operation Expenditure
OPGW	Optical ground wire
P-ECNS	Private Electronic Communications Networks
PC	Personal Computers
PCMCIA	Personal Computer Memory Card International Association
PDA	Personal Digital Assistant
RENs	Research Education Networks
RFI	Request for information
RFID	Radio-frequency identification
RLCP	Rural Libraries Connectivity Project
PGWC	Provincial Government of the Western Cape
PIA	Public ICT Access
PNC	Presidential National Commission
PNC ISAD	Presidential National Commission on Information Society and Development
POGW	Optical Ground Wire
POP	Point of Presence
POTS	Plain Old Telephone Service
PPP	Public Private Partnership
PSO	Provincial Strategic Objective
PTN	Private Telecommunications Network
QOS	Quality of Service
SEACOM	SEACOM is a privately owned and operated pan-African ICT enabler that is driving the development of the African internet. SEACOM's vision has been built on the backbone of open-access and equitable principles.
SAIX	South African Internet Exchange
SANReN	South African National Research Network
SAPS	South African Police Service
SASSA	South African Social Security Agency
SDA	State Designated Agency
SDH	Synchronous Digital Hierarchy
SES	Strategic Economic Solution
SHQ	State Headquarters
SITA	State IT Agency
SLA	Service Level Agreement
SMEs	Small and Medium Enterprises
SOE	State-owned Enterprise
SPV	Special Purpose Vehicle
STM	Synchronous Transport Module
SWAN	State Wide Area Network

TA	Transaction Advisor
TB	Terabytes = 1 000 Gigabytes
Tb/s	Terabits per second,
TENET	Tertiary Education & Research Network
UPS	Uninterupted Power Supply
US	United States of America
USAASA	Universal Service and Access Agency of South Africa
USB	Universal Serial Bus
VAN	Value Added Network
VLE	Village Level Entrepreneur
VoIP	Voice-over Internet Protocol
VOWLAN	Voice-over Wireless Local Area Network
VPN	Virtual Private Network
VSAT	Very Small Aperture Terminal
VPUU	Violence Prevention and Urban Upgrades
WACS	West Coast Cable System
WAN	Wide Area Network
WCED	Western Cape Education Department
WCG	Western Cape Government
WiFi	Wireless networking technology
WISP	Wireless Internet Service Provider
WMN	Wireless Mesh Network

Western Cape Provincial Department of Economic Development and Tourism
P.O. Box 979, 9th Floor, Waldorf Building, 80 St. George's Mall, Cape Town, 8000
tel: +27 21 483 8300 **fax:** +27 21 483 9162
website: www.westerncape.gov.za

To obtain additional copies of this document, please contact:
Chief Directorate: Trade and Sector Development
e-mail: farhaana.allie@pgwc.gov.za

Western Cape Government
Economic Development and Tourism