Annex 1:

BOTSWANA TELECOMMUNICATIONS AUTHORITY

COMMUNICATIONS INFRASTRUCTURE SHARING

CONCEPT PAPER

AUTHORS:

Martin Mokgware

Tshoganetso Kepaletswe

Mpho Moletsane

Date: October 2009

TABLE OF CONTENTS

PURPOSE

The purpose of this paper is to explore the concept of infrastructure sharing with the view to ultimately encourage industry to take advantage of the benefits embedded in the practice of sharing communication infrastructure. The paper will examine ways that could encourage sharing of communications infrastructure in a bid to enhance among others: faster rollout; provision of quality services; and affordable communications services particularly in rural and underserved areas. This is in recognition of the fact that the world-over, telecommunication and broadcasting service providers as well as Governments are transforming the way they do business mainly due to high cost of delivering variety of services to their customers.

INTRODUCTION

Communications infrastructure sharing generally refers to the capability of operators to share networks or the ability by independent third party(s) to buildup infrastructure with the purpose to lease for use by different service providers. Infrastructure sharing is applicable for fixed, mobile and broadcasting networks and it is becoming the best practice in undertaking business in the communications industry where competitors collaborate in order to lower their increasing capital costs and mitigate the risk of proliferating network deployment.

There are two types of network sharing, that is Active and Passive infrastructure sharing. Active infrastructure sharing involves sharing of active network components or the intelligence in the network.[i] Passive infrastructure sharing relates to the non-electrical and civil engineering elements of communication networks.

At the beginning of communications market liberalisation new entrants tend to prefer to construct their own networks because incumbents are reluctant to lease their networks to the competitors. On the other hand regulators and policy makers prefer methods that encourage quicker deployment without duplicating efforts. That is why in some cases incumbents are mandated to lease capacity to new entrants. In Botswana, the regulatory Authority mandated the newly licensed mobile operators to lease facilities from the incumbent operator, Botswana Telecommunications Corporation (BTC) and

utilise the backhaul transmission and international gateway of BTC to encourage quicker deployment of services.

Sharing of infrastructure is a way of optimising investment in the sector and the long term benefits are closely linked with competition that eventually leads to innovation, availability and affordability of services.

CHAPTER 1

1. COMMUNICATIONS SECTOR REFORMS IN BOTSWANA

1.1 Telecommunications Policy, 1995

The telecommunications sector reforms in Botswana commenced in 1995 with the adoption of the Telecommunication Policy. The three main goals espoused in the Telecommunication Policy of 1995 are to:

- Attain universal access and service to basic telecommunication services. Government of Botswana recognised telecommunication service as citizen right comparable to basic education and primary health care;

- Promote the provision of efficient telecommunication services. Competition was to be introduced to ensure the supply of broad, reliable and efficient services in the country; and

- Attain regional balance. This came about because the telecommunication development was found to be taking place unevenly in different regions of the country particularly between rural and urban areas.

1.2 National ICT Policy (Maitlamo), 2007

The National ICT Policy is guided by the vision to make Botswana a globally competitive, knowledge and information society where lasting improvement in social, economic and cultural development is achieved through effective use of ICT.

The policy is intended to achieve among others:

- An enabling environment for the growth of an ICT industry;
- Provision of Universal service and access to information and communication facilities;
- Making Botswana a regional ICT Hub
- Government services available electronically;
- An efficient and cost-effective ICT infrastructure; and
- Increased economic diversification and foreign investment.

The policy outlines a number of initiatives aimed at developing and strengthening Botswana's technical and infrastructure so that it could support the various programmes and projects.

1.3 Legal Reforms

In 1996 the Botswana Telecommunications Corporation (BTC) Act was amended to eliminate BTC's monopoly in the provision of telecommunication services and its default status as a sector regulator. The amendment of the

BTC Act saw the enactment of the Telecommunications Act [CAP 72:03] which created the independent telecommunications regulator known as the Botswana Telecommunications Authority (BTA or the Authority) with the mandate to among others, supervise and promote the provision of efficient telecommunications services as well as promote competition in the sector. The amendment and the enactment of the Acts introduced a number of reforms into the industry.

On the other hand there is the Broadcasting Act [Cap 72:04] which provides the regulatory framework for the broadcasting market. The Broadcasting Act also mandates the BTA to be the Secretariat and technical advisor to the National Broadcasting Board (NBB) in addition to discharging such other functions as the NBB may delegate. The NBB is charged with exercising control over and supervising all broadcasting activities in Botswana[1].

It is the view of Government that the policies and legislation will enable Botswana to secure a key regional position in the emerging global information society by creating an enabling environment for the growth of a sustainable ICT industry.

1.4 Liberalisation

The reforms resulted in the liberalisation of the sector, which was meant to introduce competition in the voice and data markets, as well as enable

[1] BTA Strategic Plan, 2009 - 2016

growth across all sectors of the economy. In early 1998 the Authority licensed two mobile operators namely, Mascom Wireless (Pty) Ltd and Orange Botswana, then Vista Cellular (Pty) Ltd and one fixed line operator, the incumbent Botswana Telecommunications Corporation, which maintained its monopoly in the fixed telephony segment. The BTA on the other hand directed the mobile operators to utilise backhaul transmission and international gateway of BTC to encourage quicker deployment of services. The BTA further mandated national roaming among mobile operators. As competition intensified and the market moving towards maturity, mandatory national roaming and infrastructure sharing requirements were lifted as the country embarked on further liberalisation of the market with competition taking the centre stage.

In 2000 the Authority began to license value added network operators such as Internet Service Providers (ISPs) and Data providers to enhance competition in the provision of internet and data services.

1.5 Further Liberalisation

Further liberalisation, which intended to introduce all round competition among sector players came into effect in 2006 and brought among others: service and technology neutral licences; the opening up of the international gateway; lifting of restrictions on Voice over Internet Protocol (VoIP); and self provisioning by mobile operators. The technology and service neutral licensing regime brought with it a Public Telecommunications Operator

(PTO) Licence which allowed the two mobile operators and one fixed line operator to provide same products and service under a single licence. All the three operators applied for a PTO licence and were duly granted the same by the Authority. The ISPs were also required to apply for new licences in the form of Value Added Network Service (VANS) Licence, which authorised them to provide a wider variety of value added services including services offered through Voice over Internet Protocol (VoIP)[2].

The introduction of further liberalisation measures was driven by the desire to increase efficiency and competition in the sector. The intention was to address issues of accessibility, affordability, service quality and the introduction of new products and services in the telecommunications market.

The success of market liberalisation highly depends on the proactive regulatory policies and incentives in place and their proper implementation. As the market evolves further, complex models of business operations start to emerge and incumbents would in most cases opt for and concentrate on measures that would pull down competitors. Incumbents find it difficult to seize opportunities that could generate significant revenues for them under the pretext that they are safeguarding their competitive edge.

In the broadcasting market, the liberalisation of the airwaves occurred in 1998 with the licensing of the first two privately owned radio stations being Yarona FM and GABZ FM. Initially the two stations were licensed to broadcast within a radius of 50 kilometres targeting Gaborone and the

[2] Further Liberalisation Study on Telecommunications Industry of Botswana. Ovum 2006

environs. This meant four radio stations, including RB1 and RB2 were now in operation in Botswana.

With regard to television, Botswana television was launched in 2000 as the first major television service in the country. The station broadcasts on both satellite and terrestrial infrastructure. Hitherto Gaborone Broadcasting Company, GBC was providing a limited television service around Gaborone on a terrestrial free to air service.

In 2007, three new nationwide radio broadcasting licenses were issued resulting in Yarona and GABZ FM extending their services outside Gaborone and the introduction of a new radio station, being DUMA FM. In an effort to minimise the cost of infrastructure development, the three services formed a transmission company, known as Kemonokeng, which is responsible for providing transmission for all of them. This thus formed the basis for infrastructure sharing on a limited basis.

CHAPTER 2

2. TYPES OF INFRASTRUCTURE SHARING

Infrastructure sharing is mainly in the form of Passive and Active network elements[3]. This paper will later on explore and elaborate on the different models that operators could adopt when sharing network elements.

2.1 Passive infrastructure

This type of sharing relates to the utilisation of the non-electrical and civil engineering elements of the communication networks by multiple operators. The passive components may be owned by one operator and leased to other operators. This might include rights of way/easements, ducts, pylons, masts, trenches, towers, poles, equipment rooms and their related power supply, air conditioning, and security.

2.2 Active infrastructure

Active infrastructure involves operators sharing active electrical network components or the intelligence in the network.

[3] Trends in Telecommunication Reform, 2008. Six Degrees of Sharing - ITU

2.3 Network Elements

Some of the elements under the different types of infrastructure sharing can be summarised as shown in table 1 below.

Table 1: Network Elements

Active Infrastructure Elements	Passive Infrastructure Elements
• Radio base stations • Microwave radio links • Network Switches • Transmit / receivers (TRX) • Radio Access Nodes (RAN) • Broadcasting Studios • Multiplexers • Antennae • feeder cables	• Towers/masts/Pylon • shelter/equipment rooms • trenches • poles • security systems • air conditioning equipments • generators & or power supplies • rights of way • Backup Batteries

CHAPTER 3

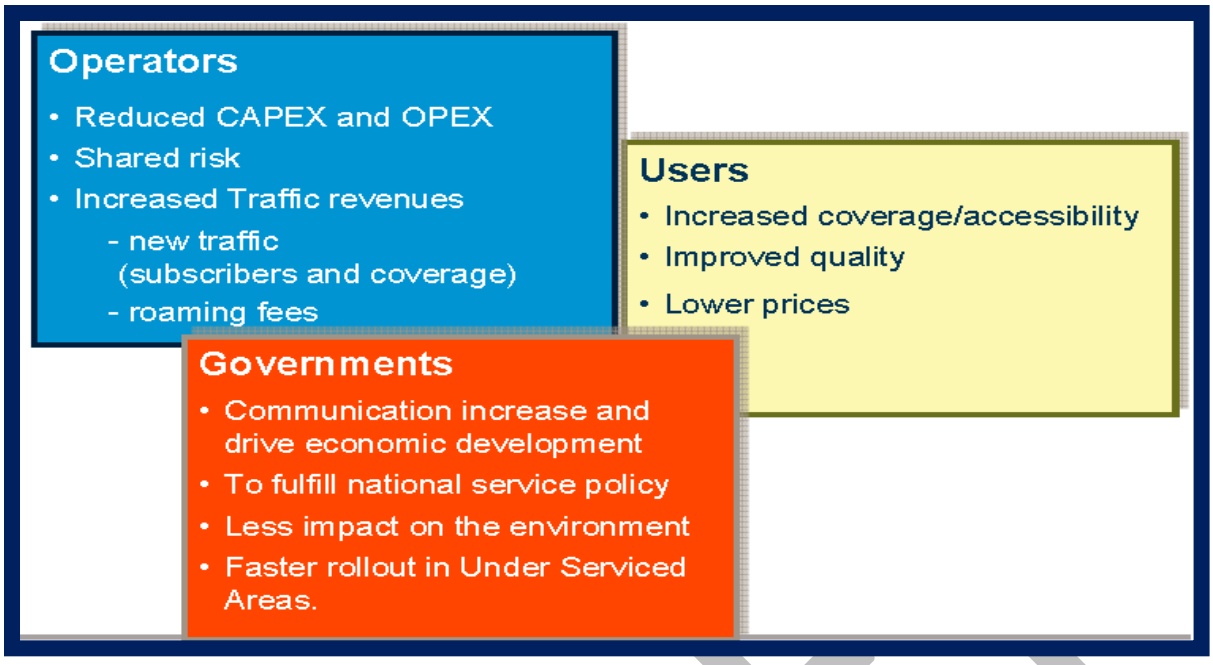
3. BENEFITS OF SHARING

3.1 Stakeholder benefits

The real value of infrastructure sharing goes well beyond concepts like revenue, turnover and efficiency rates. Its greatest benefit lies in the power to connect communities and people together at low cost, a concept that is held in high esteem by the BTA and the Government of Botswana through the Ministry of Transport and Communications' national ICT plan.

Infrastructure sharing offers an opportunity to share limited resources among service providers, and in so doing increasing coverage of areas without services and reducing costs and time associated with deployment of new structures.

Sharing brings about a number of benefits to different stakeholders, which can be summarised in the following diagrammatic presentation:



Source: Ericsson

3.2 Competition

Sharing infrastructure has the potential to create favourable conditions for attracting investment that leads to growth and a competitive sector. From the regulatory perspective, sharing enables operators to survive and compete. Opportunity for equal access to all is being created which in a way encourages entry into the market without unnecessary duplication of networks.

Where sharing is encouraged or mandated for purposes of reducing barriers to entry, the markets are attractive to new investors. Sharing may also be used to encourage the entry of new players where the market exhibits

"natural monopoly" characteristics[4]. For example in Botswana the competition on the local loop and national backbone may be encouraged through infrastructure sharing, where it is not economically feasible to duplicate the networks.

3.3 New sources of revenue

New entrants are a source of revenue to incumbents since they do not have to deploy their own networks but rather lease capacity from existing infrastructure owners.

3.4 Cost minimisation

Operators are able to save money on construction (CAPEX) and operation (OPEX) of the network. The fixed and sunk investments involved in deployment of networks are high and irreversible, and as such risky and costly. This is also compounded by the need to continually upgrade infrastructure to adopt new technologies. The capital investment is spread amongst several operators rather than be borne by a single operator. This encourages more and quicker roll-out or coverage as well as quickens time to market products and services[5].

[4] Booz, Allen, Hamilton "Telecom Infrastructure sharing: Regulatory enablers and economic benefits"

[5] For instance, in Botswana the commercial FM stations are sharing the investment risks by using a single company (Kemonokeng) to distribute the broadcasting FM signal and this should contribute to their sustainability in the market.

3.5 Affordability of services

With lesser and lesser investment going into building new infrastructure, consumers will benefit as retail prices are likely to be reduced.

3.6 Improved quality of service

Insufficient base stations (Base Transceivers Stations – (BTS)) largely account for increased rates of congestion and poor service quality across networks. As a result, sharing has potential to improve Quality of Service across networks since operators will be able to deploy many BTS as they will share the cost of infrastructure development.

3.7 Knowledge sharing and exchange of ideas

Various players sharing infrastructure are likely to share new ideas and knowledge on the challenges they experience in relation to their common business unlike where service providers are working in complete silos.

3.8 Service innovation

With lesser investments going into new deployments, service providers are able to focus on consumer needs by offering more variety and choice. The focus will be more on service competition than on infrastructure competition in order to meet the ever evolving consumer expectations.

3.9 Reduction of electromagnetic emissions

Sharing can reduce the proliferation of base stations across a given geographic area and hence reducing public perception on electro-magnetic emissions from base stations which may pose a health risk to those living close to the telecom base stations. Since erection of some network elements such as towers will be reduced this will have a positive impact on the environment making it aesthetic and healthy.

3.10 Efficient use of scarce resources

Infrastructure sharing promotes efficient use of scarce resources such as spectrum and rights of way. Non-replicable resources such as rights of way can be shared by allowing operators to share trenches and ducts, which allows for optimal use and alleviation of land availability problem.
Spectrum sharing on the other hand can be promoted by allowing operators to share the backhaul transmission network using one frequency band.

At national level one operator may be given exclusive rights of way to lay the cables for the backbone and/or access networks on the basis that it will be operated on the open access principle.

With respect to international gateway facilities, such as submarine cable landing stations these can be opened for collocation and connection services so that service providers can directly compete in the international services market.

3.11 Universal Access and Service

Since sharing of infrastructure reduces the capital and operational costs of deploying new networks, the savings that would be derived from sharing of infrastructure could be channelled to develop and reach out to rural areas that would otherwise be left out in the expansion of the networks.

It can, therefore, be concluded that Infrastructure sharing makes good business sense and there is no doubt that if managed appropriately, according to fair commercial rules, it will bring benefits to the economy and the consumers.

CHAPTER 4

4. INFRASTRUCTURE SHARING MODELS

4.1 Passive Sharing Models

The passive elements are mainly the non-electrical and civil engineering components of the communications infrastructure which can be shared by several operators while maintaining distinct networks. Passive sharing is applicable to all forms of communication be it fixed, mobile or broadcasting. Some of the passive elements that can be shared are shown in pictorial form at Fig.1 below.

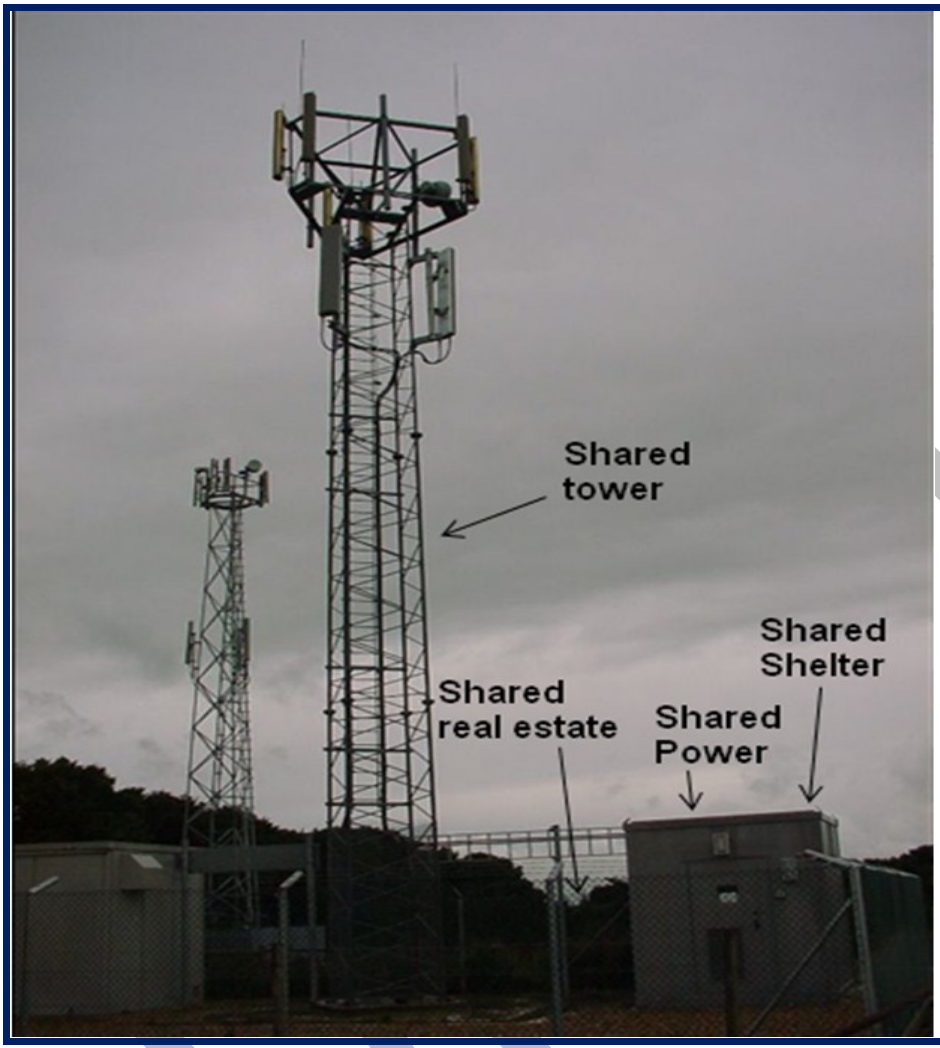


Figure 1: Passive Network Elements ***(Source: ITU)***

Given the varied elements of the passive infrastructure, countries choose or adopt different sharing models based on their respective environments. Others would promote duct sharing and others would restrict themselves to sharing of shelter or equipment rooms only whilst others would be

comfortable with sharing masts and towers. Some of the models which have been adopted in different situations are discussed below.

4.1.1 Tower Sharing

Figure 2 below indicates that towers used for mobile telecommunication networks could be shared by more than one operator instead of each constructing own towers next to each other. The sharing can also be either in the form of leasing or operators may construct the towers jointly and share the cost. In Botswana the sharing of towers on the telecommunication networks was done when the two mobile operators leased space on the BTC towers to mount their antennae. On the broadcasting side the three commercial stations have also leased space on the BTC towers for their antennae in certain areas.

In other jurisdictions there are tower management companies whereby separate licensees share a single network which is run by a separate entity on behalf of the licensees. For example, in Tanzania 3rd parties have built their own infrastructures in rural areas for lease and use by different service providers (Millicom, Vodacom, Zantel, and Celtel).

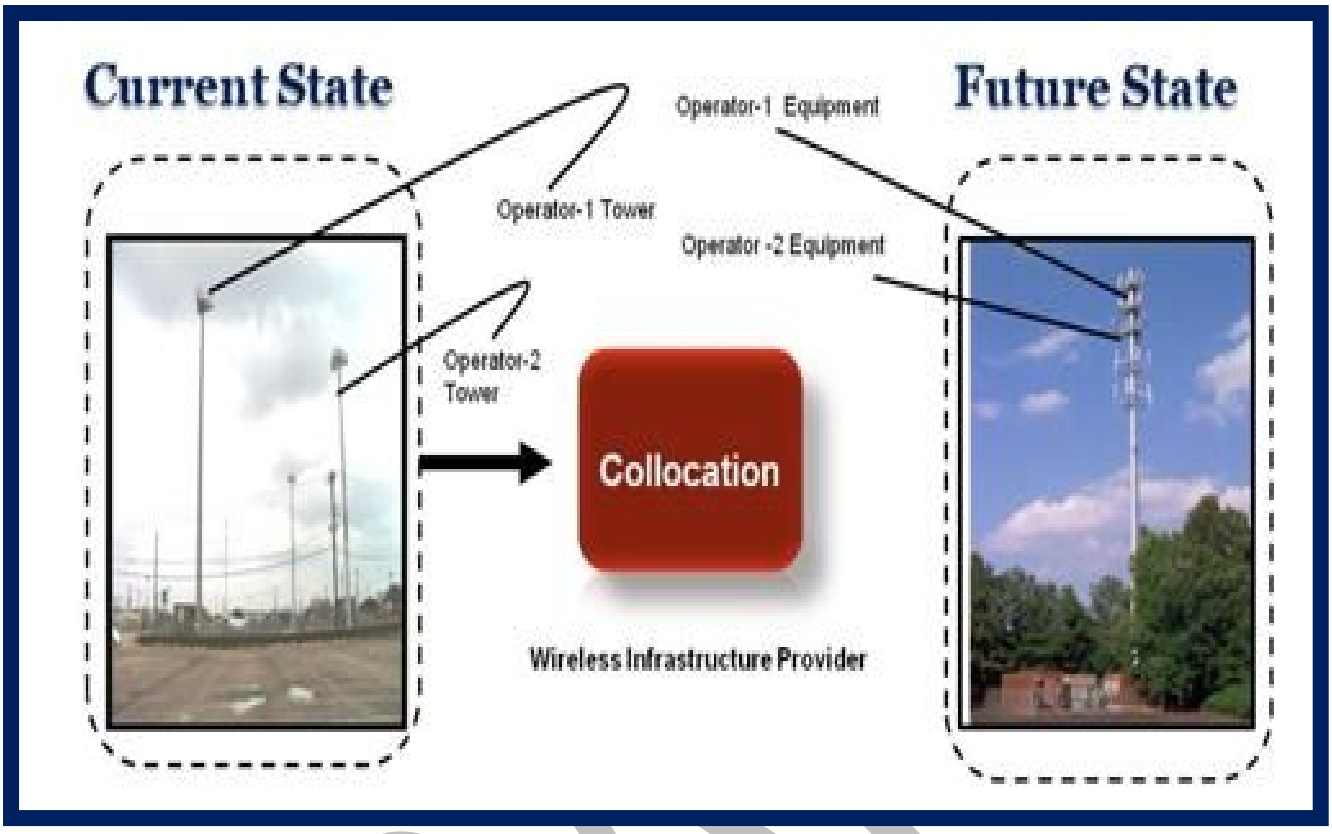


Figure 2: (Source: www.gtowers.com)

4.1.2 Site Sharing

Site sharing is where a collection of passive network equipment for communications is placed at the same site. Under site sharing arrangement the site owner provides secured space for equipment of the sharing partner. Companies sharing sites also have access to all sites related infrastructure such as power, water etc. In addition the companies may share other services such as security services, standby power supplies, air conditioning etc.

4.1.3 Sharing trenches

Trench sharing takes place when operators share the trench with each other to lay cables and ducts. Trench digging is one of the major costs in laying down infrastructure. It also causes disruption and inconvenience to the public. Examples of Trench and Duct sharing are shown pictorially in Figure 3 below:

Passive infrastructure sharing (non-electronic components)

Ducts

Trenches

- Cables
- Ducts
- Splitters
- Shelters
- Generators
- Air-conditioning equipment
- Diesel electric generator
- Battery
- Electrical supply
- Technical premises
- Easements, ducts and pylons

Note: This is a non-exhaustive list including inter-modal network elements.

Source: Jim Forster, ITU and ARCEP[13].

Figure 3: Ducts and Trench sharing (***Source: ITU Trends 2008)***

4.1.4 Sharing ducts

Some operators have pipes or ducts with sufficient space for running cables of others. Duct sharing is therefore beneficial particularly where new entrants to high-speed broadband services are allowed to use cable ducts of other telecom operators particularly those with significant market power. By encouraging duct sharing, the costs to new entrants should be significantly reduced and therefore will improve the likelihood of more providers looking into deploying services, and increasing the choice to end users. In France, the regulator mandated France telecom to lease its ducts to other operators.

4.1.5 Sharing dark fibre

Where it is economically unviable to deploy fibre or where ducts cannot be accessed it is recommended that dark fibre (un-lit) be shared. This is the fibre that is lying unused in the ducts of the incumbent operators. It is more like leasing out the spare fibre that the incumbent has. **For instance, BTC fibre on the backbone network, which is unutilised, may be leased to other operators such as Mascom, Orange and VANS.**

4.1.6 Rights of way

It is not practical for all newcomers in the market to dig trenches and mount poles/masts everywhere especially in crowded areas like cities and towns. Usually one or two companies have rights to do so and therefore, for roll out

of national fibre networks it is ideal to allow access to these passive network elements which would bring down costs and rapid deployment of national fibre network infrastructure and services.

4.1.7 Sharing with non-telecomm companies (municipalities)

Another opportunity for sharing passive infrastructure elements is with operators outside telecommunications. This usually happens where fibre networks are used to manage operations such as oil pipe-lines, power transmission, and railways. Each requires its own fibre for management purposes, but it is easy to add fibre strands with a different wavelength either before or after construction. This results in increased capacity[6].

In Africa an example could be the Cameroon-Chad oil pipeline where 12 out of the 18 fibre cables installed will be available for use by telecommunication operators. The Kenya power and light; and Tanzania's TANESCO are other examples where this type of sharing is found.

[6] An example in Botswana could be the collaboration between BTC, WUC and BPC since all these Corporations are engaged in utility services that are similar in deployment.

4.2 Active Infrastructure Sharing Models

Active infrastructure sharing involves sharing of active electrical components or the intelligence in the telecommunication network.
On the mobile networks the active infrastructure sharing may be in the form of sharing of the radio access network (RAN), core network, backhaul transmission and spectrum sharing. While on the fixed network, active infrastructure sharing involves sharing of the backbone and access network. On the Broadcasting side active sharing may involve sharing of studios and multiplexers.

The sharing of active elements may be very complex and needs thorough appreciation of all parties involved. The active elements are mainly critical for the delivery of services. In most cases it is feared that sharing of active elements may affect the competition among operators, as it is believed it has the potential to reduce the competitive edge of operators due to increased interdependency. This type of network sharing is restricted in some jurisdictions since it could encourage anti-competitive behaviour such as collusion on prices or service offerings.

However, some of these anti-competitive behavioural concerns have to be weighed against the infrastructure sharing benefits and the technology advancements that allow for differentiation of service providers' offerings in the market. It has been argued that the anti-competitive behaviour would just

have to be balanced against the alternative of having no services at all, particularly in remote and inaccessible places.

4.2.1 Mobile Networks

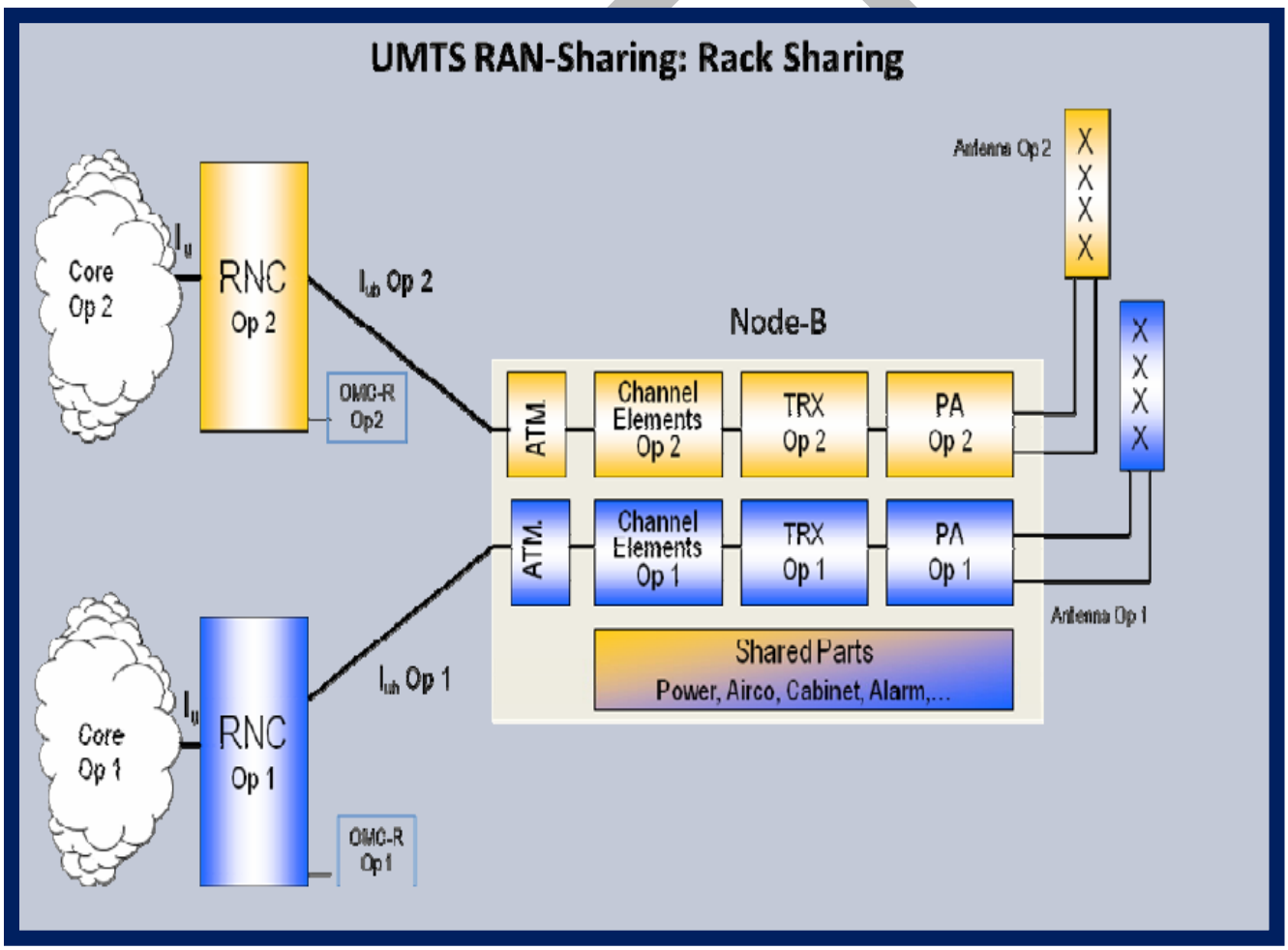
The “active elements” of the mobile networks are the electrical and electronic components such as antenna systems, radio base stations, transmission systems etc. The active elements of the mobile networks may be shared by operators using different frequencies. As indicated above, the active infrastructure on mobile networks is complex, but it is technically feasible and it has been implemented in other countries. The equipment manufacturers can supply the systems specifically designed for the active mobile sharing. The active mobile sharing has been mainly implemented in the deployment of 3G networks. This sharing in the mobile networks has been mainly on the radio access network, core network, backhaul transmission network and spectrum sharing.

4.2.1.1 Radio Access Network

The radio access network contains a number of devices that are necessary to control the transmission and reception of radio signals. The radio base stations transmit and receive (TRX) components and the antenna systems are the core elements of the radio access network. The operators may share the radio access network or only share the rack housing the equipment..

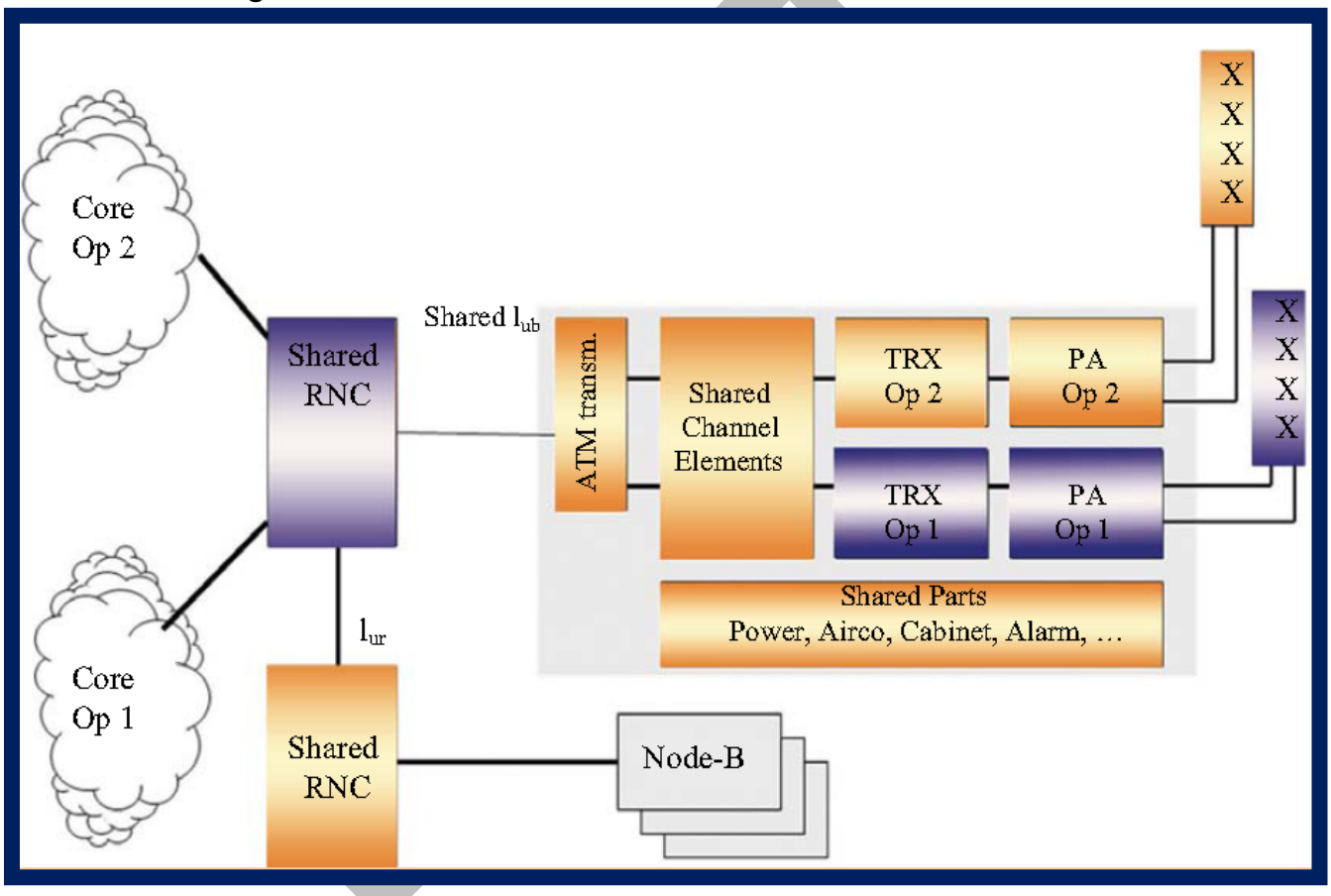
4.2.1.2 Rack Sharing

In rack sharing the service providers share the equipment cabinet, Power supply, air conditioning and alarm systems while they maintain separate antenna system, channel elements, TRX and power amplifiers. A typical rack sharing for the 3G radio access network is illustrated in figure 4 below:



4.2.1.3 Figure 4: Full Radio Access Network Sharing

In full RAN all the elements of the radio access network are shared save for the TRX, power amplifiers (PA) and antenna system. The TRX, power amplifiers and antenna systems are not shared to allow operators to independently use the assigned spectrum. Where the spectrum can be shared, operators may also share the TRX and the PA. A typical diagram illustrating the full sharing of the radio access network of a 3G network is illustrated in figure 5 below:



4.2.1.4 Figure 5: Core Network

The mobile core network performs several functionalities that are essential for the provision of services, such as the billing system and customer database. The database in the mobile network is mainly Home Location

Registers (HLR) and Visitor Location Register (VLR) which contain information on the customers and they can be reached (located).
The information contained in the core network is commercially sensitive and confidential that is why it may be very difficult to share the mobile core network for competing operators. However, the core network may be shared through other means such as National Roaming and Mobile Virtual Network Operators (MVNO).

4.2.1.5 National Roaming

Under national roaming operators agree to use each other's networks to provide services in geographic areas where they have no coverage. In general a wholesale tariff agreement is applied in national roaming. National roaming may be an effective way for operators to extend their coverage into rural or remote areas, which are not commercially viable. Operators may roll-out competing networks in urban areas but allow each other to roam on their networks in rural areas.

In Botswana national roaming was used in the initial licensing of the two mobile operators. The country was divided into two licensing packages and national roaming made mandatory between the two operators. The mandatory requirement for national roaming was cancelled when the two networks had covered each other's areas.

The main disadvantage of national roaming is that there may be no quality of service differential between competing networks and the price competition may be limited due to the wholesale roaming charge. National roaming is on the increase in some countries such as in Egypt, Jordan, Morocco, Oman and Saudi Arabia.

4.2.1.6 Mobile Virtual Network Operators

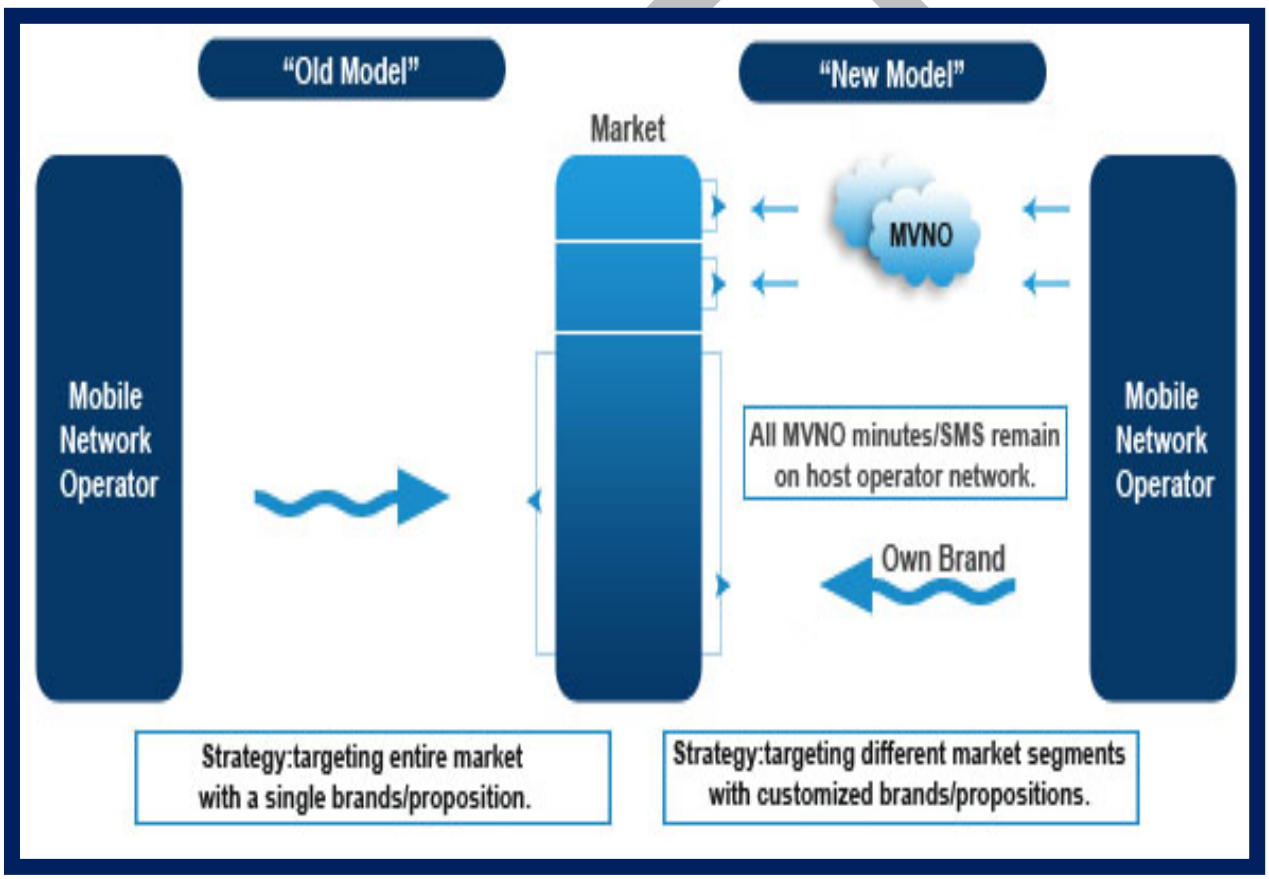


Figure 6: (Source: www.mobilemondaymadrid.com)

MVNO is another form of infrastructure sharing and there are various forms of MVNOs e.g. simple mobile service provider where the provider operates

without any network facilities just simply buy and sell airtime. Typical MVNOs have their own back-office infrastructure and only re-brand their services with various tariff packages. In other markets there are mobile virtual network enablers (MVNE) who provide back-office and infrastructure services to MVNO and have no relationship with customers.

4.2.1.7 Backhaul Transmission Network Sharing

In countries such as Botswana with low population density and sparsely populated rural areas the backhaul transmission may be a bottleneck for the mobile networks deployment. Backhaul transmission sharing is when operators agree to share transmission link (either microwave or optical fibre). For example, a base station in a remote village with low traffic may require only 2 Mbits/s and the two operators may agree to deploy a 34 Mbits/s high capacity transmission link to carry all their traffic.

The backhaul transmission sharing in Botswana during the initial licensing was mandated by requiring the two mobile operators to lease capacity from the fixed operator, BTC. However after further liberalisation mobile operators were allowed to self-provide transmission links. The backhaul transmission sharing may also enable operators to share the optical fibre, which may not be economically viable for a single operator to deploy its own.

4.2.1.8 Spectrum Sharing

Spectrum can be shared in three dimensions i.e. time, space and geography. The spectrum sharing which is feasible under the infrastructure

sharing is through the geographical separation. If the operator is assigned spectrum for national usage and the network is not covering a certain area, the spectrum may be shared with another operator through a leasing agreement or selling those usage rights in that area. This form of sharing spectrum sometimes is referred to as spectrum trading. In many countries including Botswana the regulatory framework does not allow secondary trading of spectrum.

4.2.2 Fixed Network

In the fixed network active infrastructure sharing is mainly implemented to promote and enhance competition on the backbone and access network.

4.2.2.1 Local Access Loop

Local Loop Unbundling (LLU) is the process where operator's access network (the physical wire connection - copper cables - that run from customer premises to the telephone exchange) is made available to other service providers. Service providers are then able to upgrade individual lines to offer services such as high speed Internet access direct to the customer.

LLU is generally opposed by the incumbent monopoly operators who are mandated to open up to competition. The incumbent operators argue that LLU amounts to being forced to provide competitors with essential business inputs. Some argue that LLU stifles infrastructure-based competition and

technical innovation because new entrants prefer to 'ride on' the incumbent's network instead of building their own. It is also argued that the regulatory interference required to make LLU work (e.g., to set the LLU access price) is detrimental to the market.

New entrants, on the other hand, argue that since they cannot economically duplicate the incumbent's last mile, they cannot actually provide certain services without LLU, thus allowing the incumbent to monopolise the respective potentially competitive market(s) and stifle innovation.

The point of contention by other service providers is that alternative access technologies, such as Wireless local loop (WLL) have proven uncompetitive or impractical compared with providing servicing through LLU.

Finally, the other argument advanced by service providers is that the incumbent operators generally did not construct their local loop in a competitive, risky, market environment, but under legal monopoly protection using taxpayer's money. This means that incumbent operators should not be entitled to continue to extract regulated rates of return which may include monopoly rents from the local loop.

4.2.2.2 Transmission Backbone network

The telecommunication backbone, mainly the optical fibre network connecting the major urban centres, has the natural monopoly

characteristics. It is highly improbable that multiple operators can lay the national backbone optical fibre in Botswana due to the huge cost, low population density and the associated distance. However other technologies such as microwave (point-to-point) links may be used on the backbone network. The main limitation of microwave links is that they have limited bandwidth and this means that the links would not be able to meet the future broadband services requirements.

The existing national optical fibre network is currently owned by BTC, which is a vertically integrated operator, participating both on the wholesale and retail market. There is a possibility that the BTC may discriminate other downstream competitors by granting its own retail arms more beneficial treatment with the intention to distort competition in the market. The discrimination may be by means of pricing or non-pricing. On the non-pricing matters the vertically integrated operator may employ delaying tactics in processing the orders of the competitors or not provide sufficient information necessary for introducing new retail services.

The infrastructure sharing regulatory framework has to aim at enhancing the competition at the backbone level and ensure that other competitors have confidence that the integrated operator will not abuse its position in the market. In this regard some regulators will look at alternative policy and regulatory models such as accounting separation and operational separation (functional and structural), in which the access network is separated from the core network so that equivalent access services can be offered to all competing network and service providers. Some of these models may

become important in the future, particularly with the move towards privatisation of incumbent, next generation IP networks and the convergence of services.

4.2.2.3 Accounting Separation

Accounting separation requires that a company should prepare separate accounts for each of its business units by identifying and allocating the costs and revenues associated with each business as well as the dealings between them. The aim of introducing accounting separation or providing separate financial statement for each business unit is to explicitly observe charges between the business segments. Separating the business segments facilitates an analysis of the information derived from the accounting records and provides an opportunity to examine if there is cross-subsidy between the services provided by a company particularly in the retail and wholesale markets. This consequently makes it possible to view inter-company transfer pricing and to monitor whether price discrimination or prohibited cross subsidies are occurring. Accounting separation is a potentially significant development in enhancing competition in telecommunications as the bulk of many countries networks is owned by incumbent operators.

4.2.2.4 Functional Separation

Functional separation requires a vertically-integrated company to establish a business unit to service its upstream wholesale customers which is separate from its own downstream operations. The separate upstream unit would then

have a commercial incentive to service all customers fairly and not discriminate in favour of the operator's own downstream business. In other jurisdictions the unit would be set up as a limited company and kept as a wholly owned subsidiary, while others would set up different divisions or departments.

The main objective of functional separation is to create a unit with a high degree of autonomy and independence from its parent company. The independent unit will provide market confidence and serve all customers on an equal basis regardless of whether they are internal or external customers. Functional separation also allows the operator to continue to enjoy many of the benefits of vertical integration, so long as these benefits are not based on the leveraging of market power derived from monopoly infrastructure, or infrastructure which is uneconomical to replicate. It is very important that under functional separation the boundaries are clearly defined and "china walls" are created between the separate units and other parts of the organisation.

The table below summarises the main components of functional separation;

Table 2: **Functional separation components**

Separation of Functions • Creation of separate business unit or subsidiary responsible for the production and sales of the services in question, for example the wholesale of telecom services; • Mandatory requirement to supply all operators on non-discriminatory basis;\ • Separation of operational support systems; • Separation of brand
Employees Separation • Employees are not permitted to work at both separate unit or subsidiary and the main company; • Physical separate offices and place of work • Separate pay structure and incentives; • Separate Unit employees has to adhere to certain code of conduct and needs to be trained about the regulatory requirements;
Information Separation • Flow of information is limited between the separate unit and the parent company; • Separate access systems are implemented to ensure that the information exchange for specific needs; • Separate information management systems
Financial Separation • Accounting separation • Separate budgets • Financial autonomy
Strategy Separation • Separate management; • Independent and separate Board; • Independent strategic investment decisions
Regulatory Monitoring & Compliance • Independent complaint handling committee; • System of reporting regulatory breaches; • Sanctions applied in the case of default; • Publication of performance indicators; • Publication of regulatory compliance

Functional separation has been implemented in some countries to some varying degree. The functional separation models have been implemented in UK, New Zealand, Italy and Australia and these will be discussed in the chapter under International experience.

4.2.2.5 Structural separation

This is where the incumbent infrastructure is broken-up into various companies with different ownership. For example the retail service provision may be run by another operator; whereas the network infrastructure side is run by an independent company. Policy makers and telecommunications regulators consider structural separation and divestiture of the competitive and non-competitive activities of incumbent operators as a means of countering what is viewed as serious anti-competitive activity by incumbent operators. Structural separation may take a variety of forms involving different degrees of actual separation of assets ranging from divestiture of monopoly facilities to some form of 'internal' separation of the activities within the integrated operator. Any separation will depend on the company's current form of ownership and organisation and the type of uncompetitive behaviour to be resolved. Examples of actual structural separation of competitive and non-competitive activities of an incumbent include:

Vertical ownership separation means that the uncompetitive market is separated from a vertically integrated operator, which has a monopoly-like position in the market, and is placed into a different limited company. The

new company can, for example, be sold to a separate private owner or several owners. This form of structural separation means that the incentive to discriminate against companies operating in the retail market is eliminated.

Separation into reciprocal parts means when the bottleneck part of the market is divided into smaller reciprocal parts which contain both the part of the operation that is subject to competition and the part of the operation that is non-competitive. This division into smaller entities can be made on the basis of geographical dimension or a product/service dimension.

Club ownership means that the bottleneck resource is owned jointly by several companies operating in the part of the market that is subject to competition. This means that the incentive to discriminate against competing stakeholders is basically eliminated.

An example of Structural separation in the telecommunications market is being implemented in Singapore where the country is deploying the Next Generation National Broadband Network (NGNBN). The next generation access networks will be mainly based on optical fibre as it is not economically viable to duplicate the networks. Many countries are coming with different models on how to encourage competition in the NGN. The Singapore model for implementing structural separation in the deployment of Next Generation Network is discussed in the International experience chapter.

4.2.3 Broadcasting Network

Infrastructure sharing in Broadcasting has been implemented in many countries mainly through the use of a single signal distributor for the various broadcasting stations. Sharing is now more pertinent in the digital environment, since a single digital multiplexer can carry an increased number of channels.

Traditionally, the definition of a broadcaster was known to be the builder and operator of infrastructure that enables the purveyance of content through broadcasting apparatus, as well as the nature and quality of content itself. In the digital environment, a distinction has been made between the infrastructure side of broadcasting and the content side. This has lead to an evolution of broadcasting business models that take into consideration these differences.

In Botswana, the broadcasting landscape comprises of two terrestrial free to air television services, being Botswana Television and Gaborone Broadcasting Company. There are five FM radio broadcasting services. Being Radio Botswana, RB 2, Yarona FM, GABZ FM and Duma FM.

Of two television services, BTV has the biggest amount of both transmission and production infrastructure with transmission sites in all of the major villages and now rolling out to the remaining 40 percent of the population on terrestrial free to air. In addition BTV is available on satellite through out the

country. GBC on the other hand is covering only Gaborone and the surrounding areas.

For the radio services, Radio Botswana and RB2 are available to more than 60 per cent of population, expected to get higher as the current transmission network roll out ends by the current plan period.

The private services of Yarona Gabz and Duma have a presence in some major villages as well as Gaborone and Francistown through a collective private transmission company called Kemonokeng.
It is thus obvious that the broadcasting infrastructure is owned primarily by the Department of Broadcasting Services. There has not been much proliferation of broadcasting sites to date as the private broadcasting industry is still in its infancy. Consequently an opportunity exists to ensure a coordinated rollout of broadcasting services without proliferating sites.

In the SADC region, a recommendation has been made through the Communications Regulatory Association of Southern Africa (CRASA) to encourage infrastructure sharing. To this effect, several countries have come up with policies that support infrastructure sharing as discussed in the chapter on International Experiences.

CHAPTER 5

5. INTERNATIONAL EXPERIENCES

The huge investment needed to deploy networks is putting operators under pressure to share infrastructure. Infrastructure sharing has of recent started gaining momentum all over the world.

5.1 Mobile Networks Sharing

Some of the initiatives on sharing on mobile networks in various countries are summarised in Table 3 below:

Table 3: **Mobile Network Sharing (2001- 2008)** ***(Source: Ovum)***

Country	Operators	Type	Date
Canada	TELUS Bell	RAN sharing	10/10/2008
Bangladesh	Citycell Warid Telecom	RAN sharing	20/6/2008
Norway	Network Norway Telenor Mobil	National roaming	3/4/2008
Romania	Vodafone Orange	Site sharing	17/3/2008
Spain	Telefonica Moviles Spain Yoigo	National roaming	11/3/2008
UK	T-Mobile UK 3 UK	RAN Sharing	18/12/2007
Japan	EMOBILE NTT DoCoMo	National roaming	17/12/2007
New Zealand	Vodafone NZ NZ Communications	National roaming	5/12/2007
Australia	Optus Vodafone Australia	RAN sharing	19/11/2004
Sweden	3 Sweden Vodafone Sweden Orange Sweden	RAN Sharing	22/10/2003
Sweden	3 Sweden Vodafone Sweden	RAN Sharing	18/4/2001

5.2 Functional Separation

5.2.1 United Kingdom

The United Kingdom implemented a functional separation based on a voluntary agreement between BT and Ofcom. The Agreement is legally binding and constitutes a supplement to existing sector regulation and competition legislation. The Agreement was reached after has carried out a strategic review of the telecom market in 2003 and identified that BT still dominated an unstable telecommunication market and, in spite of its level of detail, the existing *ex ante* regulation could not rectify this dominance or the problems resulting from BT's control of the national local loop. Ofcom proposed three possible solutions to the BT problem i.e. complete deregulation, referral to the competition commission for investigation of the market imperfections and behavioural and structural changes within BT in order to provide equal access among others.

Instead of referring the matter to the Competition Commission, Ofcom decided to accept the undertakings from BT to rectify the competition problems through the implementation of functional separation. BT established a separate unit called Openreach responsible for providing the wholesale services to the market on non-discriminatory basis. The BT functional separation is illustrated by the diagram below:

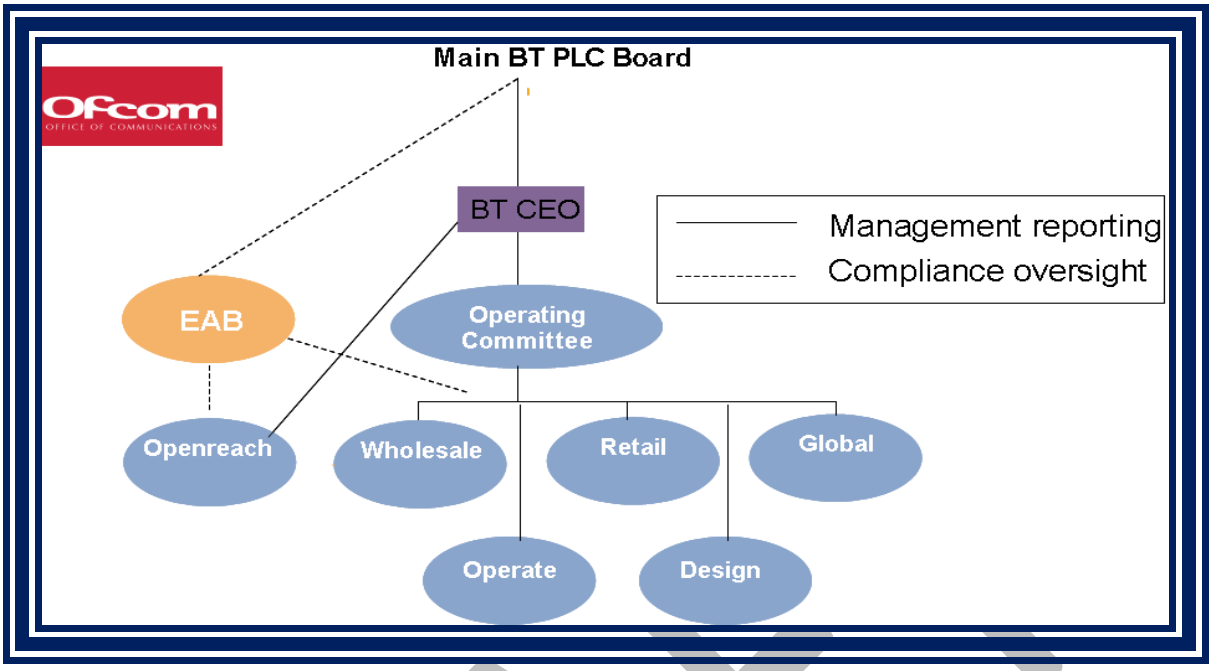


Figure 7: BT Functional Separation Structure ***(Source: BT)***

Equality of Access Board (EAB)

- Monitors, reports and advises on BT's compliance with the Undertakings
- Chaired by BT Group non-exec director, with three independent members plus one senior BT manager
- reports directly to BT Group plc Board
- reports annually to Ofcom and publishes a summary report as part of BT's annual compliance report

The BT commitment on functional separation includes an enhanced non-discriminatory undertaking, designated as 'Equivalence of Input' (EoI).

'Equivalence of Input' (EOI) means that BT shall provide a number of wholesale products to all operators (including its own retail operation) on the same terms, at the same price and with the same delivery times, level of service, IT systems and processes. All operators shall also have access to the same information about products, services, systems and processes, etc.

5.2.2 New Zealand

The New Zealand functional separation model is similar to the UK the main difference is that it has been introduced through legislation. It has similar high level details and complex and comprehensive as the UK model. The functional separation divides the company into three components comprising a retail component, a wholesale component and a network component. The Regulatory Authority monitors compliance of the separation.

5.2.3 Italy

The functional separation in the telecommunication market in Italy was initiated based on the principle of equivalent treatment and non-discrimination. The regulatory authority, Agcom issued a decision in 2002 mandated that all operators using Telecom Italia's wholesale services are to be treated equally. It ordered that the business divisions of Telecom Italia dealing with end-user services shall be separated from the divisions working with network operations, both for access lines and transmission. A separation between the information systems of the network and

commercial divisions were also be implemented, and this separation is examined annually by an independent auditor. Internal procedures were also introduced to ensure that the services are offered on non-discriminatory basis and also prevent confidential information (concerning competing operators), which is being used by the network divisions, from being utilised by the business divisions offering services to end users.

5.2.4 Australia

Australia implemented a functional separation of the operator Telstra in order to promote equal treatment and transparency for the wholesale customers. Telstra is required to retain separate resale, wholesale and network divisions, including a separation of personnel and premises. The separation was implemented by the Australian regulatory authority in 2005.

The implementation of the separation of Telstra was primarily initiated by the government through legislation in 1997. The legislation stipulated that Telstra was required to draw up and provide the government with a draft proposal for operational separation. The government specified in particular that one of the fundamental objectives of separation was to establish a transparent model that ensured that Telstra did not favour its own retail activities at the expense of wholesale customers while allowing Telstra to gain legitimate benefits from vertical integration. The national competition authority is responsible for ensuring that Telstra complies with its undertakings.

5.3 *Structural Separation*

5.3.1 Singapore

Singapore has taken a policy decision that the Next Generation National Broadband Network (NGNBN) must be communications highway of the future, for all consumers and businesses in Singapore, capable of 1Gbps connectivity and beyond. With regard to Next generation networks the policy objective is to ensure that all consumers benefit from vibrant and competitive, reasonably priced, and innovative next generation services delivered over the network. Having realised that NBN infrastructure requires high capital and that it will not be economically feasible to duplicate the NBN, the IDA developed NGNBN industry structure which structurally separates the passive network from the active infrastructure.

The figure below shows the NGNBN industry structure:

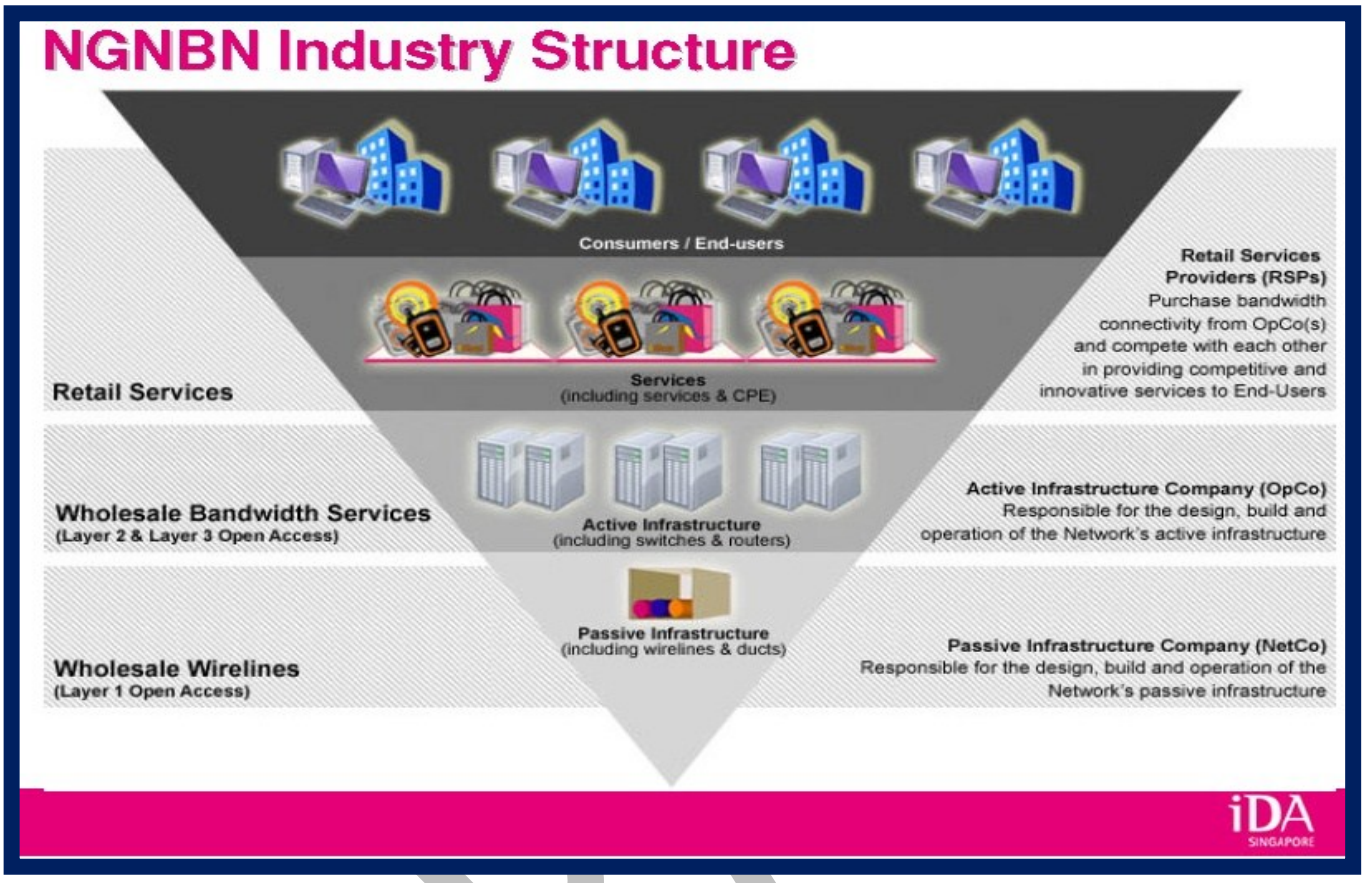


Figure 8: NGNBN Industry Structure ***(Source: IDA)***

The passive infrastructure company (NetCo) is structurally separated from other Facility Based Operators (FBO). The FBO licensees are not allowed to own more than 30% in the NetCo. The NetCo tender has been awarded to Singtel consortium and they have already started rolling out the fibre to every household and business and the target is 60% coverage by 2010, 95% coverage by 2012 and the roll-out should be complete by 2013. The minimum bandwidth requirement is 100 Mbps on downlink and 50 Mbps on uplink scalable to 1 Gbps. The NetCo lease the passive fibre to the active infrastructure companies. The active infrastructure company (OpCo) is responsible for providing the electronic components of the networks such

as switches and routers and it sell the bandwidth at wholesale price to the retail companies. The OpCo has been awarded to StarHub consortium and there is requirement of functional separation between StarHub and the OpCo. Both NetCo and OpCO are mandated to offer services under the standard approved interconnection offer which stipulates the prices, terms and condition for the mandated services. The economic characteristics of the NGNBN layers are illustrated in the figure 9 below:

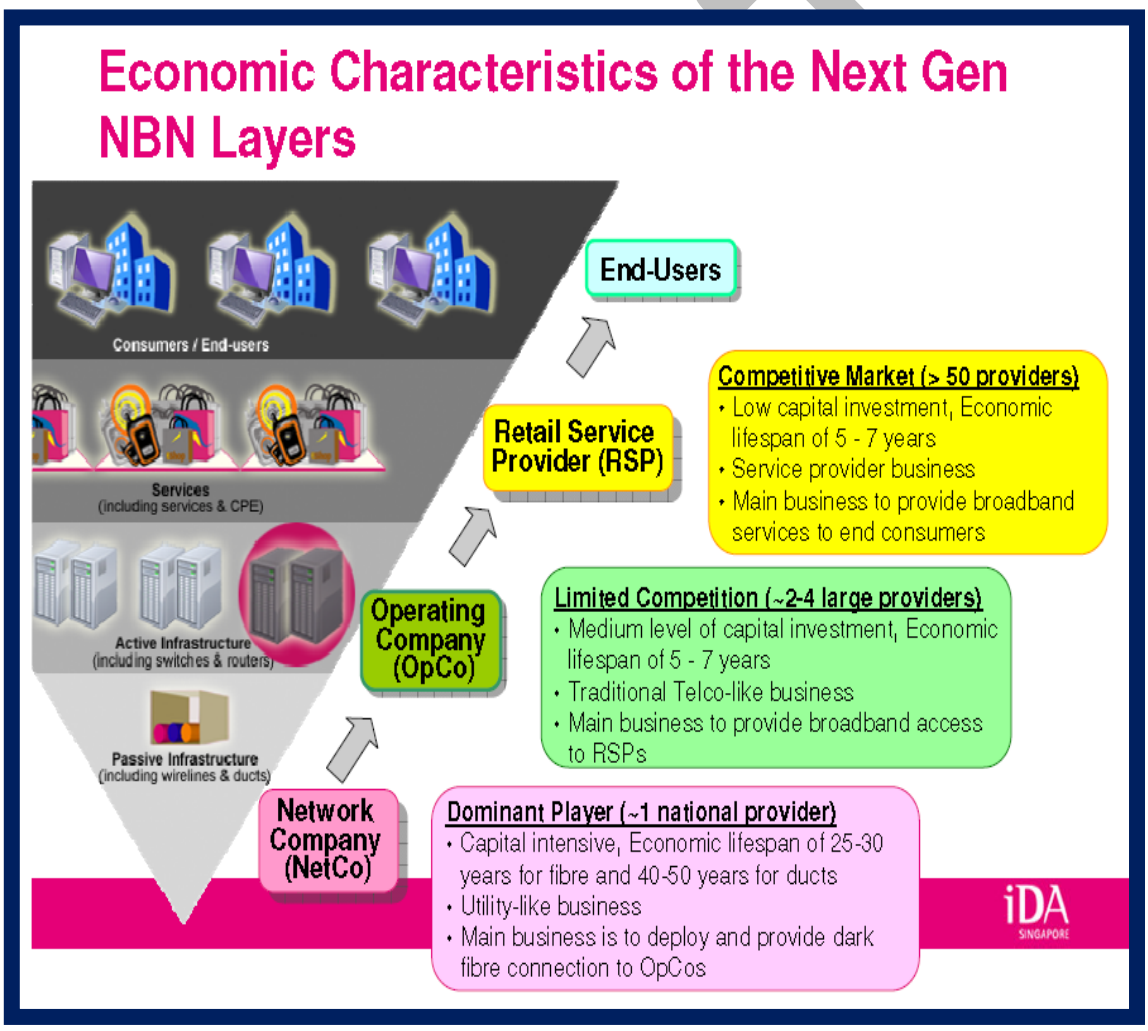


Figure 9: Economic Characteristics of NGNBN Layers ***(Source: IDA)***

5.4 Passive Elements

5.4.1 Nigeria

In Nigeria, most telecom operators no longer invest on base stations, but rent from already built ones by Helios Towers and IHS Limited, the two famous telecom infrastructure companies in the country.

The issue of co-location is taken so seriously by NCC that the operators now rented base stations and mounted their antennae on them. NCC disclosed that operators were concentrating more on laying fibre optic cables underground and later connecting them to the few existing base stations for data and voice transmissions.

Nigeria has described co-location as the next best thing in the telecommunications industry and has taken the phenomenon seriously with the support of all other sectors.

5.4.2 India

Initially, Indian telecom operators were only allowed to share passive infrastructure such as towers, power units and buildings; and in April 2008 the Regulatory body issued new Guidelines with the view to reduce call tariffs and increase rural connectivity, which have been welcomed by the leading operators. These provide for sharing active infrastructure among service providers, based on mutual agreements entered among them.

“Active infrastructure sharing is limited to antenna, feeder cable, nodes, radio access network and transmission system only. The new guidelines have also made the approval process for setting up towers simpler and easier. According to the new guidelines, individual companies would be able to set up towers without entering into a partnership with the telecom firms. The move followed the Telecom Regulatory Authority of India's (TRAI) decision to end a levy on service providers that was used by the state-run Bharat Sanchar Nigam Ltd (BSNL) towards rural telephony, which was found commercially not lucrative

5.4.3 Malaysia

In Malaysia tower sharing is being implemented by three major operators, viz, Maxis Communications Bhd; Celcom Bhd; and, Digi Telecommunications Sdn Bhd. According to the Maxis website, as of June 2008 the company was sharing nearly 43% of its towers with other players.

5.4.4 South Africa

According to Delta partners, a Telecom advisory and investment company, tower sharing agreements are likely to be concluded in Africa, particularly South Africa in the next 12-24 months. Currently, MTN and Vodacom are said to be involved in some of form of sharing, site swapping’. Delta confirms that a recent announcement in March 2009 saw an agreement between

Vodacom, MTN and Neotel to roll out a shared fibre optic network for backbone transmission.

5.4.5 Middle East and North African countries (MENA)

Different forms of infrastructure sharing are possible, ranging from basic unbundling and national roaming, to advanced forms like collocation and spectrum sharing. In the MENA region, National Roaming is used extensively in countries like Jordan, Morocco, Oman, Saudi Arabia and the United Arab Emirates. Unbundling is now starting to gather pace, with Egypt and Saudi Arabia as leaders. Other forms of sharing are bound to develop, given the expected returns to incumbents and new entrants alike.

In liberalised fixed markets like Bahrain, Egypt, Morocco, and Saudi Arabia, growth and success rely on sharing the incumbent's local loop, given the difficulty to roll out competing access networks. Market reports indicate that since local loop unbundling was enforced in Morocco, the first six months saw 19% growth in the broadband market.

5.5 Broadcasting Sharing Experience

Infrastructure sharing has also been implemented in the broadcasting industry in various countries. The experiences of countries such as Mauritius, Tanzania, South Africa and UK on broadcasting infrastructure sharing are summarised below:

5.5.1 Mauritius

Mauritius has established a signal distribution and multiplexing company, Multi Carrier Mauritius Limited which is wholly owned by the government of Mauritius. It provides transmission services for three analogue public broadcasting television services in the main island of Mauritius and one analogue service for the island of Rodriguez. It also provides transmission services for six free to air digital terrestrial television services and four radio channels. In addition, MCML provides transmission services for three AM radio broadcasts, including a foreign radio service. It also provides services for seven FM radio broadcasts which include four private broadcasters.

MCML also provides production facilities such as outside broadcasting equipment and microwave links.

5.5.2 Tanzania

Tanzania is another country that has adopted broadcasting policies geared towards infrastructure sharing in broadcasting. The country has adopted a separate licensing framework in which there are three recognised key players in the broadcasting value chain. These are the Multiplexer, the Network infrastructure service provider and the content provider. Two network service providers have been licensed. One is for the public broadcasting services and the other one for the private broadcasting service. In addition two multiplexers have been licensed catering for the public service broadcasting and the commercial services respectively. These

entities are obliged to provide transmission for the more than 50 analogue terrestrial services in country during and after the digital migration process. This policy has also enabled the content providers to concentrate on the development of content without having to worry about the expenditure on infrastructure. As a result, the film production industry in Tanzania has grown to the extent that it is substantially supporting the Africa genre movie channel of the DSTV (Africa Magic 2).

5.5.3 South Africa

Although, the Electronic Communications Act in South Africa came about in recognition of the transformation in broadcasting and telecommunications technology and the clear distinction between the infrastructure and content in the broadcasting value chain, there is still a certain degree of complexity due to the broadcasting legacy in that country. This has resulted in some major challenges in achieving the goal of infrastructure sharing.

The Public Service Broadcaster, SABC is serviced by SENTEC, which provides the transmission network. Ideally SENTEC should be able to provide services to all other broadcasters. However, the major broadcasters such as Etv and MNET have their own infrastructure and thus do not need SENTEC services. In addition, under the digital platform, broadcasters retain the frequencies they have and thus have the potential to be both network service providers and multiplexers in addition to carrying their own programs. Thus the level of infrastructure sharing in this scenario is not as would have been desired.

5.5.4 United Kingdom

Infrastructure sharing in Broadcasting is given impetus by the services of private broadcasting infrastructure providers. Three commercial multiplexing licenses were issued in the United Kingdom with two of them going to one company which now provides transmission facilities for all of terrestrial television services and for many other radio services including BBC radio. The licensee also provides other services such as satellite links, outside broadcasting facilities etc.

CHAPTER 6

6. CHALLENGES OF INFRASTRUCTURE SHARING

Even after network-sharing partners have selected an operating model, their deal can still run into unexpected difficulties once it is put into action. Some of the challenges of communication infrastructure sharing are summarised below:

6.1 Capacity bottlenecks

The original network may not have been designed to carry the traffic of two networks or new services. To remove the bottleneck, the partners may have to upgrade the network or incorporate additional equipment. For example some towers are not designed to carry many antennae.

6.2 High Investment Costs

The investment costs associated with civil works or reconfiguring the network (such as integrating IT systems) are relatively high and the operators are reluctant in planning with additional capacity to accommodate additional players in future unless there is guarantee that it will be rented out.

6.3 Competition Issues

Some of the network elements are very critical for competition purposes and operators may be reluctant to share them. For examples operators are reluctant to share network switches holding commercial sensitive information. In other areas where network coverage is used as a competitive edge, operators may be reluctant to share the towers if sharing will speed the roll-out of the competitor.

6.4 Service Innovation Limitations

Infrastructure sharing may limit the capability of the infrastructure owner to fully exploit its network capability. For example, if the back-haul transmission bandwidth capacity has been leased to another operator, the infrastructure owner may not be able to offer the 3G services from the base station unless the back-haul transmission bandwidth is upgraded.

6.5 Maintenance

The issues of site maintenance, repairs etc. need to be clearly spelt out in the infrastructure sharing agreement so that there is no confusion during the implementation.

6.6 Quality of Services

Quality of service may be a major issue when operators are sharing infrastructure since a failure on one network element may negatively affect the quality of the service provided by another operator. For the backhaul transmission links failure may affect the cellular services quality of service by increasing congestion or drop calls.

6.7 Misalignment of Network Service Providers

The operators may be at different stages of maturity having different visions and objectives. For example, the new entrants may be keen on introducing new generation of technologies while the incumbent may want to continue with their legacy technologies.

CHAPTER 7

7. CONCLUSION

Infrastructure sharing may in fact be a pre-requisite for growth and encouraging new entrants as long as it is managed properly. As indicated earlier sharing can promote competition although it can also raise competition concerns since it has the potential to reduce innovation and freedom of action of operators.

Sharing may be mandated in some circumstances depending on the market structure. Significant engagement is required to make sharing work in practice whether initiated by regulation or by commercial agreement.

Infrastructure sharing in fixed telecoms networks may present an opportunity to promote competition. Botswana Telecommunications Corporation has ample capacity in its network which is not fully utilised taking into consideration the amount of dark fibre in the backbone network. The same capacity abundance applies to the national terrestrial broadcasting network which is very much under utilised. Taking into consideration the market size and that it is not economically viable to duplicate the national backbone network and terrestrial broadcasting network it is proposed that the Government of Botswana should consider establishing a separate entity to provide the services at wholesale level on an open access to all other operators. The company should own the national backbone infrastructure,

international connectivity bandwidth, national terrestrial broadcasting network and broadcasting satellite bandwidth.

BTA would have to put in place regulatory measures including reviewing the licensing framework, to efficiently cater for the regulation of the wholesale entities. The regulatory framework has to aim at enhancing competition at the backbone level and ensure that other competitors and service providers have confidence that the wholesale operator will not abuse its position in the market. A detailed study would have to be undertaken to look into ways of regulating the newly established structures.

In conclusion it is recommended as follows:

- That Policy guidelines on passive infrastructure sharing should be developed:

- A costbenefit analysis study should be carried out on the local loop unbundling, in order to identify the competition bottleneck on the local loop and recommend the appropriate measures for enhancing the competition: and

- Detailed study on how BTC infrastructure could be shared on an open access principle.

REFERENCES

1. "Consultation paper on infrastructure sharing of cellular mobile companies", Pakistan Telecommunication Authority, August 2007
2. "NEPAD Broadband ICT Infrastructure for Eastern and Southern Africa, 3rd draft", by CTO and ICT Consultants (Pty) Ltd for NEPAD e-Africa Commission
3. Booz, Allen, Hamilton "Telecom Infrastructure sharing: Regulatory enablers and economic benefits"
4. Guidelines on Collocation and Infrastructure sharing, Nigerian Communication Commission
5. ITU Regulatory tool kit
6. ITU's Trends in telecommunication Reform, 2008 "Six Degrees of sharing"
7. Ofcom, "Infrastructure sharing – promoting competition in next generation fixed access" Chinyelu Onwurah, " a network sharing forum for Telecom operators, January 2008
8. The Standard newspaper, Kenya, Nairobi, "Sharing of infrastructure key to cutting costs", by Michael Ouma
9. www.234next.com "Telecom industry operators opt for infrastructure sharing", May 2009
10. www.developing-telecomms.blogspot.com : Developing telecoms Watch: Infrastructure sharing to have a major impact in emerging markets in 2009?", February 2009
11. www.docstoc.com, "Infrastructure sharing in rural areas: Barriers and Enablers for sharing infrastructure in rural areas", Birgitta Blakstad Poolsaar, Ericsson, August 2009
12. www.express computeronline.com, "Sharing telecom infrastructure'
13. www.hindu.com, The Hindu newspaper, "TRAI proposes sharing of infrastructure"
14. www.itu.int/ITU-D/treg/Events/Seminars/ GSR 2008
15. www.nowwearetalking.com.au/news "Separation - The facts", June 2008

16. www.ofcom.org.uk “Duct & Pole sharing – a guidance note on Oftel Policy”, June 2002
17. www.siliconindia.com/shownews, “Telecom operators welcome new terms for infrastructure sharing’, April 2008
18. www.tmcnet.com “Telecoms operator makes case for infrastructure sharing”, May 2009