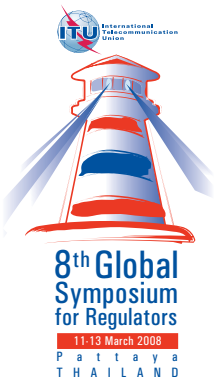

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EXTENDING OPEN ACCESS TO NATIONAL FIBRE BACKBONES IN DEVELOPING COUNTRIES

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INTRODUCTION

Many developing countries have either begun or are about to begin deploying a range of technologies that will offer broadband access at a local level. These technologies include among others WCDMA, HSDPA and WiMAX. As a result of continued technological development and increasing deployment, prices for communications services to users in developing countries are decreasing and the numbers of users and amounts of usage are gradually increasing. As demand escalates, one or more operators (and in some cases, national government) will ultimately see a need to offer or build out a national fibre network. As this is an extremely capital intensive initiative, the likelihood is that there will only be one or two operators, at least initially, one of whom covers just the main urban markets of the country involved.

A critical aspect of promoting wider broadband use is ensuring that national fibre infrastructure is affordable. This is important to encourage the "critical mass" of users and the services and applications that they might use. This critical mass is facilitated through economies of scale which allow for lower costs and therefore affordable pricing and subsequent take-up of services. Whilst competition at the international level has often driven down the price of bandwidth, national bandwidth prices in developing countries are set by one or two providers and as a result, often remain high.

Policy-makers and regulators globally need to develop policies that constantly seek to create the right incentives and conditions for competition. However, in the developing country context the imperative is on how to accelerate the growth of a critical mass of users and getting national wholesale costs and delivery right is a crucial task.

Increasingly, the sharing of infrastructure by telecommunication operators based on a model of open access is one such option attracting greater policy attention. While liberalized markets already have numerous models of infrastructure sharing, such as co-location, national roaming, local loop unbundling, other forms of sharing are also starting to emerge that involve sharing the passive and active elements of the network. Once incumbent operators perceive their value as revenue generating opportunities, these innovative arrangements also facilitate the development of new entrants and service providers. However, effective and enabling regulation and policy are critical to facilitate such arrangements.

This type of regulation and policy must address two broad issues which are often viewed as the stumbling blocks to speedy roll-out of national infrastructure: first, regulation needs to address problems emanating from access to bottleneck facilities, namely, where a single dominant infrastructure operator provides or leases facilities. A typical remedy in this regard would include for example, regulations on access to essential facilities. The second issue that policy and regulation needs to address is the situation where none of the existing market players are investing in rolling out high-capacity infrastructure to un-serviced or under-serviced areas.

This paper examines the concept of infrastructure sharing on the basis of "open access" and its implications for developing countries. In economic terms, "open access" allows multiple downstream competitors to share a bottleneck facility that is a critical input for the services that are provided. In most cases, the bottleneck facility is owned by one of the firms that also compete in the downstream market. The access is open if it is sufficiently non-discriminatory that all competitors can access the bottleneck facility at the same cost and level of quality. This ensures that if the bottleneck provider competes downstream, that it cannot discriminate against its competitors and realize a significant competitive advantage by virtue of its ownership of the facility.[1]

This paper also examines infrastructure sharing on the basis of open access where the owner of the bottleneck facility does not compete in the downstream market, but rather serves those who do. Where the bottleneck facility owner is a commercial entity, it will depend on the commercial strategy it has chosen. If it has decided to sell relatively low volumes of capacity at the highest price it can obtain, it will need to be persuaded that the market is enlarged through a different strategy that involves sharing: monopoly status tends to encourage this commercial approach. If it accepts that higher volumes will be sold if offered at lower prices, it has an incentive to share and may only need to be convinced to do this more effectively and fairly.

The paper will examine the parameters of open access in a concrete manner, moving beyond broad principles such as, "technological neutrality" and "non-discrimination" to explain what is at stake technically, and on a regulatory level, in connecting a wide range of different service providers to fibre networks. The paper will also identify instances where the sharing of national infrastructure has occurred and what can be learned from the experience. The paper is structured as follows:

Section one outlines the importance of broadband access for developing countries and sketches the challenging questions it raises in policy and regulatory terms.

Section two examines two critical regulatory issues - bottleneck facilities and un-serviced or under-serviced areas - that policy and regulation relating to national infrastructure might address in the developing country context.

Section three examines the different ways of sharing national infrastructure based on a layer analysis. This section considers the differentiation between passive and active infrastructure and how this distinction has affected attitudes to what parts of national infrastructure might be shared.

Section four examines model approaches to national infrastructure based upon looking at different examples of infrastructure sharing from Europe, the United States and elsewhere. These examples are used to identify the challenges different examples raise for developing countries and the best practices that can be derived from these operating examples.

Section five deals with a number of policy and regulatory issues that national regulators and policy makers need to consider and address for the implementation of national infrastructure sharing.

Section six concludes with proposed "best practice" from the perspectives of the different stakeholders that are affected.

Box 1: What is Open Access?

Open Access means the creation of competition in all layers of the network allowing a wide variety of physical networks and applications to interact in an open architecture. Simply put, anyone can connect to anyone in a technology-neutral framework that encourages innovative, low-cost delivery to users. It encourages market entry from smaller, local companies and seeks to prevent any single entity from becoming dominant. Open access requires transparency to ensure fair trading within and between the layers based on clear, comparative information on market prices and services.

Source: Infodev, 2005

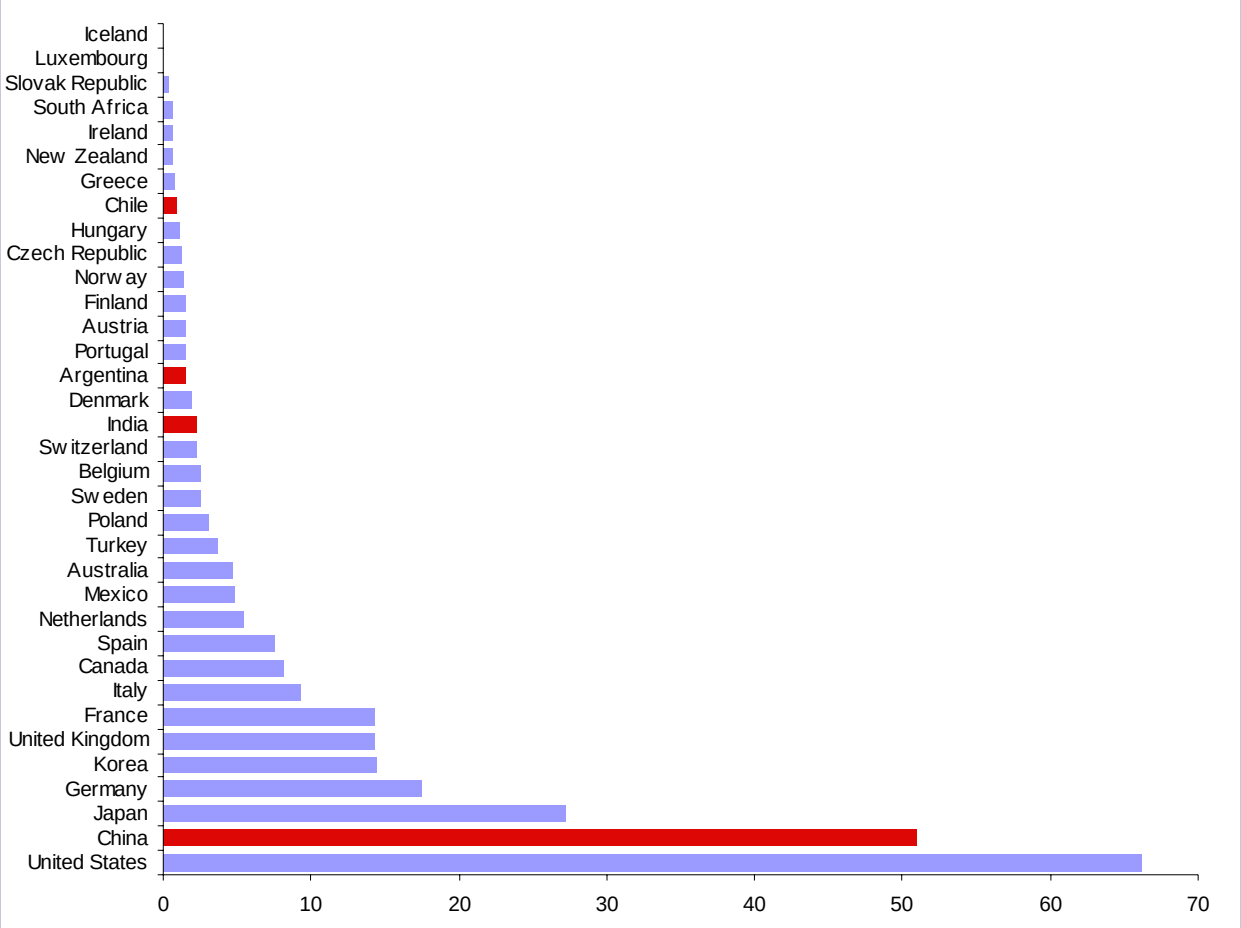
It should however be noted that it is very early days in the development of fibre backbone sharing models. There are very few existing operations of this nature and where they do exist, their development is recent. As such, this paper attempts to identify various different options based on the current knowledge and experience available. As this is a new area of regulation and commerce, government and regulators will continue to develop different practices and experiences and share those with one another as each country seeks in its own way, shaped by its domestic policy and objectives, to ensure the best approach for its needs.

1 THE IMPORTANCE OF NATIONAL FIBRE BACKBONES FOR DEVELOPING COUNTRIES

The economies of developed countries are increasingly reliant on widespread access to broadband services and applications. These are no longer just a means of communication through traditional applications such as e-mail or newer applications such as Skype or a trading channel, such as Amazon. Broadband services and the infrastructure on which they depend have become recognized as an essential input to business, education, healthcare and participation as a citizen in the information economy. These services have even been recognized as a media in their own right. The growing scale of online media use can be judged by the fact that online advertising for example will shortly exceed its television sector equivalent in a number of developed countries.[2] As will be shown in the case studies discussed later, a developed broadband infrastructure is an important attraction for the location of business and company operations and a pre-requisite for increased investment.

The Organization of Economic Cooperation and Development (OECD) countries, in many instances, have not only achieved ubiquitous access to basic Internet services, but are also succeeding in achieving high penetration rates for broadband access, which in turn facilitates more complex and effective services provision and delivery models for both government and the private sector.

Figure 1: Broadband in the OECD and selected Developing Countries



Note: Total Broadband Subscriber, by country, millions, June 2007

Note: ITU data to December 2006 in Red, compared OECD data of June 2007

Source: ITU, OECD and Regional Dialogue on the Information Society, 2007

In economic terms, arguably having access to a national broadband fibre network upon which services and applications can be built is as important a priority as building an effective national transport network. Given the central role that ICTs play in the information economy, many argue that broadband access is a similar "public good" to roads and railways and evidences strong positive externalities as a result of their existence. Without this kind of access, developing countries run the risk of enlarging the so called "digital divide" and becoming second or third class nations within the global order. Having this kind of competitively priced national broadband access becomes one more criteria of global competitiveness.

Although there are enormous obstacles to implementation in some developing countries, broadband access also offers these countries the potential for delivering government services more effectively and at a lower cost and of addressing poverty through minimizing the rural-urban divide so common to developing countries. A broadband infrastructure can, for example, better enable the economic participation of persons living outside major cities and urban centres by relocating "back-office" jobs to rural and less well-off towns and cities and attracting work outsourced from developed countries.

Box 2: Fast facts on Broadband in the OECD

- 221 million – the number of broadband subscribers in the OECD.
- 8 per cent of all broadband connections in the OECD are Fibre-to-the-home (FTTH) and Fibre-to-the-building (FTTB)
- Fibre connections account for 36 per cent of all Japanese broadband subscriptions and 31 per cent in Korea.
- 66.2 million – the number of subscribers in the United States, the largest broadband market in the OECD
- 49 USD - the average price of a month broadband subscription in the OECD
- 51 USD – the average price of fibre to the home/building (Fibre connections are nearly 5 times less expensive per Mbit/s than DSL, cable or wireless)
- 13.7 Mbit/s -the average advertised download speed in the OECD
- 1 Gbit/s – the fastest residential download speed available in the OECD (in Japan)
- 77.1 Mbit/s – average FTTH advertised download speeds in the OECD (much higher than DSL (9.0 Mbit/s), cable (8.6 Mbit/s) or fixed wireless (1.8 Mbit/s))
- 20 of the 30 OECD countries impose explicit bit/data caps on broadband connections
- 0 - bitcaps among surveyed firms in Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Norway, Sweden and the United States

Source: OECD, 2007.

Sharing infrastructure is one strategy for achieving a national broadband infrastructure more quickly than through simply letting the market take its course. For the development of national infrastructure of this kind in developing countries is often blighted by a recurring "chicken-and-egg" problem: without this kind of access, there will not be a "critical mass" of users and without the users, the social and economic impacts that national broadband access might deliver will not be felt.

2 ISSUES ADDRESSED BY SHARING NATIONAL INFRASTRUCTURE

As operators seek to expand and grow their businesses into new areas and markets, infrastructure costs represent the highest portion of the capital required. In the light of an often-expressed desire to create high-capacity, national infrastructure, developing country policy-makers and regulators are seeking to speed up roll-out on the basis that if the infrastructure can be delivered quickly, it will help enhance a favorable economic growth trajectory.

Encouraging the build-out of national infrastructure can help all key stakeholders – whether in the public or private sector – address two broad issues that often hamper speedy roll-out: first, where a single dominant infrastructure operator can be seen as controlling "bottleneck facilities"; and second, where none of the market players are investing in rolling out high-capacity infrastructure to un-serviced or under-serviced areas. Both of these issues may be present in the same country and are often linked to the way infrastructure was delivered in the past.

2.1. Bottleneck Facilities

In the case of "bottleneck facilities", usually the operator itself questions the commercial rationale for providing to others access to key infrastructure and has an unfair advantage over its competitors at all levels, but particularly in downstream markets, due to its ownership of key infrastructure elements. Most commonly, this is experienced in the price advantages that a vertically-integrated operator can give itself unless otherwise constrained: it is both its own customer and competes with the other customers it supplies. In these circumstances, the dominant infrastructure operator becomes the obstacle to both the development of new infrastructure and more generally, the expansion of competitors and market growth. The "bottleneck facilities" problem is the most fundamental of all interconnection problems as it can prevent equitable sharing of a dominant infrastructure network.

Historically, ownership of "bottleneck facilities" was in the hands of the former Government-owned operator but this pattern is changing, particularly in developing countries. In a number of instances, e.g. Africa's mobile providers, whether privately owner or related to the state-owned fixed line operators, are setting out to become vertically integrated network and service providers and thus through increased market share may well become the dominant infrastructure providers. Therefore the issue is not how a particular category of operators (fixed or mobile) behaves but more about market power and how it is exercised. In any event, as countries increasingly try to capitalize on the gains of convergence, licensing regimes are being revised to reflect unified service and technological neutrality.

To address the obstacles caused by "bottleneck facilities", regulators have had to look at how best to make a clear separation of retail and wholesale functions. Increasingly governments have become insistent that the infrastructure (network) business is as operationally separate as possible to allow completely transparent trading between the wholesale and retail sides of the business. Faced on this basis with several options by the UK regulator Ofcom, BT chose to set up a significantly more separate network company called BT OpenReach. According to its Group Chairman Sir Christopher Bland the company has two responsibilities: "…to keep the access network infrastructure healthy and to make sure that it is made available fairly and equally to all Communications Providers - leaving industry free to compete on equal terms" [3] (emphasis added).

Indeed agreeing what was needed to keep the access network infrastructure healthy formed part of its agreement with the regulator. It was allowed to have a 10 per cent investment return on Open Reach's network assets as part of agreeing to a greater degree of structural separation. However in January 2007, BT was arguing that it has not managed to achieve anything like this level and Ofcom noted that it was "aware of BT's concerns with respect to revenue and profit level in the

future". So setting the terms for overall access to a dominant infrastructure network will almost certainly involve some level of agreement over rate of return.

In the case of South Africa, the Government has taken three initiatives to address what might be described as "bottleneck facilities" issues. First, it has mandated an "essential facilities" framework that opens up key elements of national and international infrastructure (see section 5 below for details). Second, it has chosen to create a new, state-owned company called "Infraco" that will operate the national fibre network assets of two state corporations, Eskom (the power utility) and Transtel (the telecommunications arm of the national railway company). In this particular case, however, the infrastructure will be leased to Neotel, the second fixed line operator on a limited term exclusive basis, at a lower, utility rate of return. Neotel in turn can on-sell capacity on Infraco to all other service providers and operators who want to buy it. Infraco is a Government-initiated private-public partnership in response to the issues raised above, particularly the impact of high, national wholesale rates on retail broadband prices. One argument to the contrary however is that this initiative, although well intentioned, has squeezed out private investment by removing any incentive for private capital to be committed to a network infrastructure project of this nature. Finally, the government has announced plans to build a 4.7 billion Rand undersea cable around the west coast of Africa to alleviate the bottleneck caused by the exclusivity arrangements between consortium partners on SAT-3 and the arguments that the cable has reached near full capacity.

With a similar desire to speed things up and make access affordable at a local level, Knysna municipality in South Africa decided to create its own Wi-Fi coverage area to provide voice and data for its 50,000 citizens because it believed that it was only by doing it itself that it would be affordable. There are also a considerable number of other municipalities in South Africa that have tendered for "muni" networks and they are all moving towards some form of "self-provisioning" of facilities in doing so, often through a public-private partnership with existing value-added service providers and ISP's. Provided a framework is in place to enable it, the infrastructure created can be shared by any service provider on agreed terms.

If licensing is required and where the framework does not immediately allow for it, governments and regulators many have to create general authorizations or augment their licensing frameworks to enable backhaul and backbone providers. In the case of Infraco, the South African government had to promulgate legislation to create the legal entity and amend existing sector legislation to enable its licensing.[4] The TRA in Lebanon has expressed its intention to encourage infrastructure sharing through the licensing process by allowing infrastructure sharing to facilitate the fulfillment of roll-out obligations, for example for future broadband access. Similarly, Lebanon's draft mobile licences permit the licensees to construct, maintain and operate mobile networks "whether alone or with other providers".[5]

2.2. Addressing un-serviced or under-serviced areas

In the case of un-serviced or under-serviced areas, the policy intention is usually aimed at creating a greater "critical mass" of users by encouraging the roll-out of high-capacity, national infrastructure to a wider range of places than the market alone might initially sustain. In essence, this argument for sharing national infrastructure is that two or more operators sharing (and paying for access to) a common infrastructure will help finance a wider roll-out, whereas traffic from a single operator would not make the same level of routes sustainable. Although there are considerable variations between developing countries, in Africa, only less than 4 per cent of the population on average currently has access to fixed line services, let alone high-capacity infrastructure.[6] Furthermore, in some countries national backhaul is largely handled by satellite with all the negative financial consequences for those countries' balance of payments.

After liberalization, it has become clear that whilst the new private sector providers have invested heavily in new networks that have covered an increasing percentage of the population, the

capacity of these networks are often modest as many only handle voice services. For example, mobile cellular networks currently cover, on average, 67 per cent of the population in Africa and 74 per cent in Asia-Pacific, although this may rise to up to 80 per cent over the next 2-3 years. With the steady upgrade in many markets to 2.5G and 3G, national backbone requirements are rapidly increasing the world over. For example, in many African countries, national and international network requirements have doubled or tripled over the last three years and look set to keep increasing, if not at quite such a rapid pace. It is not clear whether existing microwave and satellite networks will keep pace with this growing demand.

2.3. Role of Government

Government has a key role to play in facilitating the most effective use of infrastructure assets and in identifying those parts of the country where there are gaps and getting coverage extended to them. In a very direct sense, Government will often be a significant customer and it can facilitate the key "anchor tenant" that will make a marginal location worth investing in: for example, a remote border town might connect its customs post, local government centre and school.

The facilitating role of Government can help overcome the reasons why sharing is not occurring. Cost is a compelling pragmatic reason for sharing national infrastructure but it is not always a sufficient reason by itself. During a panel in an African regulators forum last year, two major operators made it clear that they felt it was Government's responsibility to provide a particular element of infrastructure they were not providing. It happened to be cross-border links but their arguments could as easily apply to national fibre infrastructure. Also there is often insufficient trust between operators to look at how they might share national infrastructure: their experience has often been of poor delivery from the historically dominant infrastructure provider and they do not believe that this can be avoided except by them each providing for themselves.

However, notwithstanding these very real concerns from the operators, the financial prize remains considerable. The passive component of the network is estimated to constitute 40 per cent and the active component constitutes 60 per cent of the total capital cost of a network. However, fluctuations in property, steel and cement prices also affect the capital cost of passive infrastructure relative to active infrastructure which is currently declining due to price reductions of electronic components. Site acquisition and preparation costs account for approximately 20 per cent of capital costs for networks and the cost of setting up towers in rural areas tends to be approximately 30-40 per cent higher than in urban areas, given that these towers generally have to be ground-based and consume more materials. Estimates suggest that cost per kilometer of laying fibre overland are approximately USD 15 000 - 17 000 if the cable is buried directly at 1.2m depth. The price increases considerably where the cable is being laid in hard rock, and it decreases slightly when doing so in loose sand. If however the fibre is strung in urban areas on poles, the amount per kilometer is closer to USD2000/km but the maintenance cost will be much higher. It is estimated in one study that after ten years, both methods amount to approximately the same cost.[7]

Analysts examining the Middle East and North Africa (MENA) have suggested that telecommunication operators in the region will increasingly use infrastructure sharing as a strategy for new revenue generation and cost optimization as infrastructure sharing can help reduce capital expenditure components by as much as 40 per cent.[8] In the liberalized market in the MENA region for example, Bahrain, Egypt, Morocco and Saudi Arabia, growth and success rely extensively on sharing the incumbent's local loop, given the difficulty of rolling-out competing access networks. Market reports indicate that since local loop unbundling was enforced in Morocco earlier this year, the broadband market grew 19 per cent in a period of 6 months.[9] So although local loop unbundling is a regulatory remedy, it is clear that the strategic impact of overcoming bottlenecks in infrastructure is market growth.

2.4. Country Examples

The desire to create a more far-reaching national infrastructure has been the motivation of several African Governments in creating national infrastructure companies. The previous Kenyan Government prepared a plan to build a fibre network designed to cover the whole country. It envisaged that this network would either be run on contract by a private sector provider or by the former incumbent Telkom Kenya, under clearly agreed terms. A similar approach has been adopted in Uganda. In the case of the latter, the proposed network was amended to take into account fibre already laid down by existing providers MTN and utl. However, in both cases the government's proposals were presented as a way of offering a wider range of coverage and bringing national network costs down.

In India, the government has an ambitious plan to use the Universal Service Obligation Fund to roll-out free broadband connectivity at a speed of 2 MB per second across the country by 2009 in order to boost economic activity in the country.[10] The Department of Telecoms will seek to break the oligopoly of existing national and international long distance players in a bid to create infrastructure competition in the sector. According to a Department of Telecoms spokesperson, "India has only a handful of NLD/ILD operators while small countries such as Singapore and Taiwan have over 30 and 60 long distance operators respectively". Thus, however one judges the plans themselves, there is clearly an issue of infrastructure competition arising out of the existence of "bottleneck facilities".

Encouraging sharing of infrastructure at the national level by regulators can mean that the private sector becomes convinced enough to separate out its wholesale function or operate a separate passive infrastructure company. In February 2008, India's Reliance Infratel was floated as a separate company to manage the carrier's passive network infrastructure -- land, towers, generators, and power supply elements of the mobile network -- and will handle all new roll-out and network sharing deals with other operators. Although focused on mobile tower sharing, there is no reason why an operator should not create a similar company to manage the passive elements of a national infrastructure, particularly for example, the rights of way, ducts, and dark fibre needed for a fibre backbone or other backhaul network infrastructure.

2.5. Regulatory issues

From the above discussion, it is also clear that questions do however emerge regarding whether the roll out of such entities is an appropriate form of government spending? Should these networks run "at cost" as is currently being proposed and if so, on what basis? Because these organizations are not yet operating it is unclear what "at cost" will include, for example, whether it will allow capital replacement and maintenance: if not, the Government provider clearly will have an unfair advantage in the market. Therefore, it is important that regulators and policy-makers ensure that these kinds of initiatives do not have the kinds of unfair advantages that all too-often the dominant infrastructure operator was granted in the past.

Requiring existing or legacy operators to separate its wholesale function or operate a separate passive infrastructure company is not the only option. As described in Section 3 below, it is possible for regulators to authorize - or even promote - entry to an entirely new kind of business, one designed to serve as a backbone on which ride a full range of service providers, including local government entities seeking broadband access, small rural operators, and even major players looking to upgrade their microwave backhaul links to fibre. The regulatory issues here relate less to providing fair access to bottleneck facilities as these entities have incentives to provide access to their facilities: the issues relate rather to the cost of that access and ensuring the regulatory framework will allow them to enter and compete in the market, and that regulatory costs and hurdles are reduced to ensure that they can provide affordable access to their customers.

As each country is different, with divergent levels of market development and regulation, it remains difficult to list all the regulatory issues that might arise from allowing new styled infrastructure players into the market. Moreover, in some cases this may be a *legacy provider* providing backhaul and in others, a new entrant or *"greenfield licence".* There also remains the possibility of a *hybrid option* where the legacy operators are just one of many partners or investors in a joint venture or cooperative that provides backbone service. Provided the framework allowed for it, this situation might arise where (fibre) infrastructure exists which is not used for telecommunications services, such as power and transport networks, but which may offer rights of way that may be used by operators and service providers. The regulatory issues that might apply would differ according to which of these options were chosen, however, at a general level, government and regulators would have to concern themselves with the following:

- Facilitating the legal creation of these entities, be they cooperatives, joint ventures, or other;
- Enabling, where necessary, the licensing/authorization of these entities;
- The type and size of the licence fee required to ensure that licence fees do not act as a disincentive to investment and also allow for a rate of return;
- Whether spectrum will be required and if so, its assignment;
- Whether universal service obligations would attach to these licences;
- In the case of legacy providers, whether any form of price regulation is applied, and on what basis;
- Monitoring and investigation of anti-competitive complaints;
- An appropriate access regime

Box 3: Sharing with non-telecoms infrastructure operators

Cost-sharing infrastructure deals are often made because the infrastructure is being built for another reason and the cost of adding more capacity is marginal. This is particularly true for fibre networks used to manage diverse operations such as oil pipelines, power transmission and railways. Each requires its own fibre for management purposes but it is relatively easy to add fibre strands, either before or after construction. The resulting additional capacity can then be shared either by the operating company setting up its own wholesale fibre capacity sales operation or through it selling the right to sell the capacity to an independent organisation. In Africa, there are several examples of where this has occurred including: the Cameroon-Chad oil pipeline (known as the Doba-Kribi pipeline), Kenya Power and Light and Tanzania's TANESCO. In the case of the oil pipeline, 12 out of the 18 fibre cables installed will be available for use by telecommunications operators. Arrangements of this kind clearly cut the cost of building network infrastructure.

Source: Shared Infrastructure, paper for ITU Africa regional conference, Nairobi, 2007

3 WAYS OF SHARING NATIONAL INFRASTRUCTURE

In order to facilitate and ensure the sharing of national infrastructure, a variety of decisions need to be made at a number of different levels. Clearly it is important to know which of the technical elements in a national network can be shared and how this might be achieved. It is also worth noting that not all of the technical elements can be seen in the same light: terms like « passive » and « active » infrastructure, provide useful ways of approaching the different parts of the process of sharing (see Table 1 below). Moreover, simply addressing the technical elements alone does not effectively address "bigger picture" issues. Regulators need to create accepted frameworks for sharing national infrastructure based on the elements described below.

The easiest shorthand definitions of passive and active infrastructure are as follows:

- ***Passive infrastructure*** covers all the non-electrical or civil engineering elements of national infrastructure like physical sites and ducts, although it does include power supply.
- ***Active infrastructure*** covers all the electrical elements of national infrastructure like lit fibre, access node switches and broadband remote access servers[11]. However, as will become apparent in Section 3.3, the more difficult decisions about sharing are where they impinge upon the value-producing core of the infrastructure provider's business.

Sharing national fibre infrastructure involves essentially three key layers shown in the table below. The key elements shown on the right-hand side of the table summarize those items of equipment and software items that can be shared. Each layer has a set of functional rules that allows it to interface with the other layer and for information to flow over the network. In commercial terms, these technical elements are combined with considerations of "Reach" (the geographic scope of providers) and "Type of Customer" (wholesale or retail).

Table 1: Layered network elements

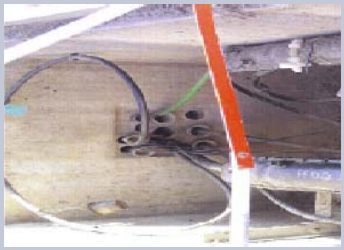
Layer	Description	Key Elements
Layer 1	Physical	Ducts, poles, dark fibre, RF channels
Layer 2	Transport	ATM PVC, Ethernet VLANs
Layer 3	Services	VPNs

Source: Authors

3.1 Sharing Passive infrastructure for national transmission

The table below lists the key elements of passive infrastructure that might be shared at the national level. Because a national backbone – whether fibre or microwave – will be used by all carriers, there is inevitably some overlap with the GSR Discussion Paper on mobile sharing. High-capacity networks in developing countries will inevitably be made up of a mixture of fibre and microwave transmission: however, the detail of the shared elements for microwave is to be found in the mobile sharing paper.

Table 2: Key elements of passive infrastructure for fibre networks

Passive Infrastructure Sharing (Non-electronic components)	
Trenches (right) and Ducts (left)  	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[12]	

Access to the physical ducts or masts (in the case of power transmission lines) and rights of way are key potential passive elements in encouraging the roll-out of national fibre infrastructure through sharing. This has two aspects, one of cost and the other affecting speed of action. National governments, municipalities and state-owned enterprises frequently charge considerable sums of money for rights of way which allow operators to carry out physical trenching of ducts (see picture above).

3.1.1 Obtaining Rights of Way

There are a number of issues that need to be addressed. At a practical level, it is possible but not desirable that every operator creates their own physical duct. Time taken in ploughing up roads to achieve this would add significantly to the chaos and disruption of the process, particularly in urban areas. But also if each operator has to buy rights of way separately, these costs will need to be passed on to consumers, thus adding to the costs of wholesale distribution. Often, the actual laying of the cable may represent only a relatively small part of the overall costs of deploying a fibre network but obtaining the rights of way adds considerable costs.

The ownership of rights of way is complicated and the legal provisions covering them vary from country to country. Furthermore, their ownership is often spread between a bewildering array of bodies including private parties, national agencies like railway companies and local organizations like municipalities or local/district authorities. These bodies often apply very different rules and procedures to obtaining them. The processes for obtaining these rights may be very slow and not always subject to clear procedures. This creates a lack of transparency for potential investors and has the overall effect of slowing down plans that might otherwise be implemented relatively quickly.

There are several ways that will help overcome the barriers to implementation raised by these circumstances and they both involve the sharing of physical ducts. The Government at a national level can persuade or insist that those bodies that have ownership of rights of way give them for a purely nominal charge on the basis that the operator who develops the physical ducts installs additional dark fibre capacity that can be lit when requested by other operators.

Government (or indeed local government) could in addition, or in the alternative, ask for fibre capacity in exchange for the agreed value of the rights of way. So for example, as the case study

from rural Virginia in the United States (see Section 4.3 below) shows, the local operator MBC gave 2 fibre strands to each of the local authority bodies which they could use for their own purposes. A rural municipality in a developed country might use this capacity to connect up its offices, schools and health care facilities.

Government at the national level can effectively do two things. First, it can simplify the ground rules for obtaining rights of way and in so doing, it can insist that the resulting physical ducts are shared by operators. Second, government can lower or prescribe the cost of the rights of way themselves as they constitute a significant part of the cost of creating national infrastructure. Lower entry costs combined with easier access to rights of way may encourage operators to consider laying fibre on routes that were previously considered uneconomic.

Regulators may not have the powers to achieve these things but they can bring them to the attention of Government and highlight the importance of them being adequately addressed. Indeed different sector regulators can use their respective power over different sectors of the economy to ensure that there are common ground rules for obtaining rights of way.

3.1.2 Ducts, Poles and Power Supply

In the face of growing conflicts resulting from demands for shared infrastructure and its impact on the growth of the national backbone, Brazil's three regulatory agencies for telecommunications, electricity and oil decided in 1999 to specify a common regulatory framework for the sharing of infrastructure. For these regulators, the infrastructure elements that needed to be shared were rights of way on private property; towers and cable channels; co-axial cables and fibres in the physical ducts or on power masts.

The same framework approach was adopted in Cameroon but in this instance, covering operators of telecommunications, television, electricity and railways under the leadership of the Cameroon Telecoms Regulator (ART) that signed an outline agreement with the operators[13]. The Nigerian Communications Commission (NCC) has also stipulated the main ways of co-locating and sharing infrastructure, adding to these elements masts, pylons, trenches, energy sources and technical locations in buildings[14]. The French regulator, ARCEP considers France Telecom's ducts to be an essential facility and the operator in a voluntary move prepared a standardized duct offer by the end of 2007, already commercially offered and to be made publicly available soon[15]. SingTel's Reference Interconnection Offer includes the terms and conditions under which SingTel will provide a requesting party with use of building lead-in ducts.[16] The newly established Telecommunications Regulatory Authority (TRA) in Lebanon has indicated its intention to promote infrastructure sharing as part of a holistic approach to telecom reform. TRA has stated its intention to promote passive infrastructure sharing of towers, masts, ducts and conduits in areas where it is not economically sustainable for multiple operators to build infrastructure and where environmental and social concerns are particularly important.[17]

The West African community adopted a regional regulatory approach to harmonizing the ICT sector that encourages infrastructure sharing. In January 2007, the Economic Community of West African States (ECOWAS) Heads of States and Governments adopted the Supplementary Acts that cover ICT policy, the legal regime, interconnection, numbering, spectrum management and universal access. The Act on Access and Interconnection in respect of ICT sector stipulates in Article 10 point 2 that "National Regulatory Authorities shall encourage infrastructure sharing between incumbents and new entrants concerning in particular posts, ducts and elevated points to be made available mutually on a commercial basis, in particular where there is limited access to such resources through natural or structural obstacles"[18].

The EU Framework Directive (2002/21/EC) has a specific article (12) on "Co-location and facilities sharing". Under this article, EU Member States can go as far as imposing facilities sharing where undertakings have the right to install facilities "on, over, or under" public or private property. Recital 23 of the same Directive explicitly mentions ducting as an object of facilities sharing.

The physical home of the cabling – whether in ducts or physical sheaths – is a key part of achieving a shared national network. Physical ducts are often scarce, under-utilized and have long pay-back periods. Opening up access to them in a variety of different ways creates incentives for sharing between operators and helps ensure maximum use of these relatively scarce resources.

3.1.3 Fibre Capacity and Splicing

Once access to the physical ducts or power transmission masts is opened, operators wanting national network capacity between different physical points then have a choice of investing in their own dark fibre or buying on a monthly or annual lease or indefeasible rights of use (IRU) basis (10-20 years) access to fibre routes. Lateral and mid-span splices can be offered, giving greater flexibility. In this circumstance, operators would provide their own equipment to connect to the network capacity they have bought and would need to be assured that there was sufficient space to accommodate potential network users. However, since IP network access equipment is of relatively modest proportions, physical space is hardly an issue.

3.2 Active infrastructure at the national level

Sharing active infrastructure is a much more contested ground as it goes to the heart of the value-producing elements of a business. The examples given below demonstrate the breadth of active infrastructure elements that might be included and the examples that follow demonstrate that whilst much is technically possible, operators will inevitably raise objections.

Table 3: Key elements of active infrastructure

Active Infrastructure Sharing (Electronic components)	Optical network unit (ONU) Access node switches Management systems Broadband Access Remote Server (BRAS) Coarse or dense division multiplexing Software (core network systems like billing)

Source: Authors

At layer two, the transport layer, the shared infrastructure operator can provide a wholesale, point-to-point fibre service to providers who can then use it to provide services across layer three - the services layer - of the network. In this case, each service provider and its associated customers are assigned to a separate Virtual Local Area Network or if the provider is using Asynchronous Transfer Mode (ATM), using separately assigned Permanent Virtual Circuits. Technical and service characteristics may vary depending on the network architecture but there is no insurmountable obstacle to sharing in this layer.

For video delivery (IP-TV and Video-On-Demand), IP networks will also be easily accessible on the basis described above but there may be issues about provisioning the necessary capacity to deliver this kind of service. However, thus far, video is far harder to deliver on a Passive Optical Network, although it can be done using a video overlay. Although possible, we were unable to find implemented examples of video delivery on a Passive Optical Network (PON), using this kind of overlay. Since PONs networks are sometimes presented by vendors as a way of an operator retaining control over the core network, there may be an understandable but perhaps unwarranted suspicion that the difficulty of creating shared services is intentional. Not having such an overlay on an IP network can save electro-optical costs but raises transport and switching costs. In summary, whilst there are some technical issues that affect the ways in which sharing might be conducted, the main issues remain policy and regulatory in nature.

Once there is a widespread fibre network, the question immediately arises as to how that capacity will be delivered to the customer's premises, whether a home or an office. To encourage speed of roll-out it may be useful to encourage the infrastructure operator to provide what has been termed a "fibre management point": in effect, this will allow competitive service providers to take the fibre capacity offered and deliver it locally. Where and how these are provisioned will depend on the density of users, the geographic characteristics of the neighborhood and the level of market development.

At a slightly more complex level, providers can each transmit on their own wavelength using either Coarse or Dense Wave Division Multiplexing over long national or international routes. A number of providers can be supported and in effect, each would be operating its own network over which it could make its own commercial decisions. With this approach, providers would treat their capacity a component of their own network and provision it accordingly. However, as far as we are aware, this separate shared network approach has only been used thus far for international cables.

Whilst the discussion about sharing active elements raised by MVNOs is beyond the scope of this paper, and is addressed in the GSR Discussion Paper on Mobile Sharing, it does clearly illustrate that active elements of infrastructure can and will be shared because of either commercial or regulatory imperatives. The MVNOs (sometimes referred to as 'thick' as opposed to 'thin') that are investing in their operations at a significant level share the following elements: the UMTS Terrestrial Radio Access Network (UTRAN), the gateway core and the core network itself. Within the core network sharing extends to Mobile Switching Centres (MSCs), U-MSCs, Serving GPRS Support Nodes (SGSNs) and GPRS Gateway Service Modes (GGSNs). Although the figures are contested, it is claimed that UTRAN sharing alone may offer 20 per cent operating savings. Indeed, the way that mobile operators outsource network operations and management demonstrates how different elements of the business can be operated by another party.

The primary barriers from a commercial point of view to this type of sharing are issues of "commercial confidentiality". Mobile operators who agree to share (or are forced to do so by regulation) run the danger that competitive operators might learn too much about their operation. From the operators' point of view, these are concerns addressed if it chooses the MVNO (rather than having it imposed) as it can align its own strategy with the MVNO. There are also issues about aligning equipment buying and interoperability. Both of these issues are more easily overcome if the services are offered by a neutral partner carrier. Or as is the case in Tanzania, an equipment vendor offers managed network services to operators on network rolled out in what otherwise might be marginal rural areas.[19]

There is also a wider issue already raised in section 2 above pertaining to when mobile operators becomes the dominant infrastructure providers. This has already happened in some African countries where there has been civil war as the damage has largely removed the presence of the historic operator. But in other countries such as Nigeria, mobile operators are making major infrastructure investments and are likely to become dominant infrastructure operators. It is worth noting that active sharing of fibre networks is likely to raise similar issues as have been raised by active mobile sharing. These include for example, concerns about consumer choice; commercial confidentiality and whether access should be mandated or merely authorized. After much (sometimes heated) discussion, there is in most African countries an interconnection agreement of some kind governing both pricing and access to the historic operator's national network. In many countries, the presence of Interconnection guidelines published by the government or regulator may also assist. In terms of national infrastructure sharing, the question is whether these same access rules apply to mobile operators if they become dominant network infrastructure providers? It is worth noting that where the backbone provider is not however competing at the retail level, concerns about consumer choice, prices and commercial confidentiality and whether these have to be mandated are less likely to present themselves. The GSR Discussion Paper on "Mobile Sharing" more appropriately examines these issues in some detail.

3.3 Using national infrastructure sharing as part of a wider broadband strategy

For the Government and regulators, national infrastructure sharing provides a number of levers that can be used to overcome barriers and speed up implementation. It cannot be said too often that different circumstances will require different approaches and that a light approach using persuasion is nearly always preferable to those requiring things to be imposed. However, it has to be acknowledged that there will times when the intransigence of major stakeholders can only be addressed by clear legislation or regulatory frameworks.

Different approaches respond to different market dynamics. If there are numerous existing or potential players wanting to roll-out a network, then a facilitating agency offering passive infrastructure assets like rights of way and Government land for sites will most likely succeed. However, if there were an appetite among operators to take advantage of it, the encouragement to share passive infrastructure could itself simply be a passive policy mechanism.

In developing countries the main challenge apart from implementing access is where there is no commercial appetite to address under-serviced areas where roll-out does not necessarily make commercial sense. In the absence of interested market players, the government might need to take the primary risk by encouraging investment in a wider national network and devising a fair and efficient mechanism to share this resource with existing market players. The issue for Government and regulators is whether they seek to duplicate elements of already existing networks or seek to "fill-in" gaps in already existing networks. The latter might easily be seen as a task for a Universal Access Fund but experience in some regions, e.g. Africa, has shown that these mechanisms do not produce speedy results in terms of national network roll-out to un-served and under-served areas.

It is however important to note that in markets where full liberalization has yet to occur, the slow progress at infrastructure investment should not be interpreted as a lack of willingness on the part of the private sector to invest. In some cases, restrictive policy and regulatory environments simply do not allow for that commercial evaluation to mature into investment and government may think that the private sector is not willing to take the network investment risk. As the Chairperson of the South African Competition Tribunal has noted, "The country's access deficit [the lack of broadband connectivity] was not due to market forces not working, but due to the fact that we have not had a working market. If there is one market that responds to market incentives, it is the telecoms market".[20]

3.3.1 Creating conditions for entry by Greenfield backbone providers

Given the competing demands on government funds for equally important services such as healthcare, water, sanitation, electricity and education for example, government might not wish to take the sole responsibility for national infrastructure roll-out but might rather create the conditions for the private sector to do so, or encourage both operator and user representation in a joint venture vehicle that might be operated by an independent private contractor.

On this basis, government might also wish to encourage a wider range of partners to participate in the national infrastructure building task. Under the right access terms, there is no reason why private sector partners might not play a role. There is also a need for bodies like universities (through national research and education networks (NRENs) to participate, both as representing the user voice and by buying bandwidth to encourage wider online access for students. Having user voices in the governance of shared infrastructure projects ensures a universal focus on the overall objective of cost-effective delivery of bandwidth to end-users. The customers and participants in such a joint venture vehicle might include: existing national operators (fixed and mobile), ISPs, large-scale corporate customers (like banks), government funded services like public universities, hospitals and clinics and government departments. Depending of the state of

development in the market, access can be offered to users in just layer one or both layers one and two as described in section 3.1 above.

Few governments have a convincing history in running “public interest” enterprises that have to operate in a commercially effective way. It is not impossible to achieve but it requires considerable skill and political subtlety and even in countries where these are available, it is not always successful. Nevertheless, it is perfectly possible for a government to grant a private sector company the contract to run some part of a shared infrastructure network on its behalf. The example of the Knysna municipal network in South Africa cited above is one where a municipality has contracted a private enterprise to provide the service. Another example at a national level is South Africa’s broadband network provider Infraco mentioned above, although it has yet to demonstrate its operating credentials. And an example at a regional basis is the Mid-Atlantic Broadband Co-operative in the United States described in Section 4.3 below.

Sharing infrastructure in a liberalized market can provide the dynamic for the roll-out of costly national infrastructure, whilst simultaneously allowing operators to compete fiercely in other layers in the market. Infrastructure sharing can be an additional tool for policy makers and regulators where Greenfield fibre backbone providers compete in the same market as existing network operators and service providers. These new Greenfield providers may be merely authorized to enter the market or actively encouraged through tax incentives and the creation of joint-venture or co-operative vehicles in which certain government players are also partners (or not). In other words, policy makers and regulators can encourage any and all potential backbone providers to enter the market rather than limiting market entry to one or two.

Where market entry is limited, policy makers and regulators then have to address other issues and decide on a long-term basis whether infrastructure sharing is a tactic or a strategy for achieving policy goals. If sharing infrastructure is used tactically, a country may reach the point where a national infrastructure is more or less in place and it might be advantageous to create a level of infrastructure competition again. For example, it may be useful to have competing infrastructure providers on key routes between cities. This approach then allows some price competition and might open up additional capacity more quickly than a single or shared infrastructure approach might do. Where market entry is open to all and competition is effective, many of these issues evaporate.

Ultimately, the requirement for sharing is a strategic need, for it allows government or the regulator to continue to intervene to ensure that consumer welfare and the positive externalities that flow from national infrastructure are protected. But whether one approaches the question either as a tactical or strategic issue, where market entry is limited it becomes necessary for the regulatory framework to contain the ability to impose sharing on those who control essential facilities and mandate the terms and conditions on which it should occur, as well as have the monitoring and enforcement mechanisms required to implement that framework.

However, in either instance two key questions arise: first, whether the creation of shared infrastructure services promotes competition and lowers prices for consumers and second, whether such arrangements serve to encourage other operators to continue to make technical innovations that lower cost and improve services? While the first question is likely to be answered in the affirmative and the latter question is slightly more complex to pronounce on definitively, both questions are directly linked to the type and quality of the access regime the policy-makers or regulators will conceive and implement in the pursuit of these objectives. This will be discussed more closely in section 5 below, following an examination of the models for infrastructure sharing that have to date been implemented. However, these two questions should not be viewed as separate inquiries. The fundamental question that emerges is whether there is competition and if so, whether it is effective?

4 APPROACHES FOR NATIONAL INFRASTRUCTURE SHARING: CURRENT MODELS

The examples listed below are all drawn from developed countries and have all been chosen because they have been in operation for some time, enabling certain lessons to be gleaned. In addition, each of the examples discussed has been funded from public funds but has been run privately.

Two of the examples (SERPANT in south-east Ireland and Mid-Atlantic Broadband Co-operative in Virginia, United States) focus on rolling out broadband networks to relatively large under-serviced areas in their respective countries.

SERPANT in Ireland was built as part of a nationally devised broadband strategy, whereas Stokab in Sweden started its work in the national capital Stockholm and extended its role and reach over time.

Although the three examples have had both social purposes and impact, the main strategic focus of each has been a desire to encourage economic development in their respective areas or country with broadband access as an incentive to help existing companies and to attract new investors.

Financially, each organization was tasked to be self-sustaining and has met this challenge over the period each has existed. None of the organizations is profit-distributing in the way that shareholders in a company receive dividends. However, MBC in Virginia does return the equivalent of profits (funds over and above its operating requirements in a given year) to participating operators using the term “capital credits”.

Also in each of the examples, public funding has been used to lower the required return needed to operate a network of this kind and thus lowered the barrier for market entry to potential service providers.

Finally, this paper also provides a number of examples of publicly-initiated fibre backbone projects at a local and national level. These illustrate some of the knotty competition issues that are involved in launching projects of this nature. Many of these projects have been designed to create an incentive for what is seen as the next generation of broadband access upgrade, Fibre-To-The-Home (FTTH).

4.1. Sweden: Stokab (Stockholm)

Stokab was founded in 1994 and is owned by Stockholms Stadshus AB, which is in turn owned by the City of Stockholm. In its own words, it was established “to promote economic growth and thereby stimulate the telecom market and ICT development in the Stockholm region, particularly in the City of Stockholm”.[21]

The impetus for its launch was a Government Bill called ‘From an IT policy for society to a policy for an IT society’ that set the objective for the country of achieving ‘[a] sustainable information society for all’.[22]

In practical terms, Stokab initially filled the gap left by the historic incumbent’s refusal to provide fibre capacity after liberalization. However, a strategic decision taken that Stokab would only offer the market the fibre-optic infrastructure (“dark fibre”), the asset that is most difficult to replicate and leave services and innovation, using the fibre, to the new telecommunications companies. This decision was a key guiding principle of the company.

Stokab's core tasks are to build, operate and maintain the fibre optic communication network in the Stockholm region and to lease fibre optic connections. The company is competition-neutral and provides a network that is open to all players on equal terms. Stokab cooperates to facilitate the rollout of infrastructure for wireless communication and drives development of the broadband market in the Stockholm region.

This formal description rather understates the key strategic role it has played across Sweden by co-operating with both private and public network operators to ensure infrastructure development on an open access basis. Once established, the company expanded the network into 27 surrounding municipalities. It has also co-operated with Nordic and Baltic neighbors on fibre links, enabling the city to become a regional ICT hub. The company also operates the City of Stockholm's internal networks to serve both administrative purposes and for other public services in the areas of education, child care, recreation and culture. The City of Stockholm sees Stokab as providing a "public service on commercial terms".

Stokab commenced its network roll-out in 1994, initially concentrating on the central commercial districts before extending to all commercial areas. There is now network through the City's area and beyond to Uppsala, parts of the archipelago, to some of the municipalities in the Mälar region via Mälarringen and also to Gotland. It has worked with both public and private housing developers and utility companies to ensure that all new housing is fitted with fibre access.[23] Its network now has 5,600 kilometres of cable.

After commercial areas, fibre grew out into residential areas, first into multi-dwelling houses, where the service operator typically provided a basement router, and then into central points in single family house areas, where it fed wireless and other access points. These access points were also provided by other service providers and real estate developers. It is interesting to note how it also tied in with local roll-outs made by others. In one suburban municipality of around 17,000 single family homes, the local electricity distributor added fibre on an open access basis to every house on their grid.

Competition soon offered positive welfare gains for consumers. Large commercial customers like banks had more negotiating powers than consumers, once they were given a choice. Stokab's roll-out was a mixture of guessing where demand might be and anticipating it through a Master Plan. With a fibre backbone over the entire area, the question came up after a few years how several providers could provide wireless access in competition with one another. However, as spectrum allocation was based upon an old model, Stokab applied for, and received a slot for broadband wireless spectrum which it opened to SME providers in the more rural part of its area. Progress with this initiative has been stalled partly for internal reasons but also because products like Wi-MAX still have teething problems and remain an unproven technology, particularly in the face of limited spectrum availability. Furthermore ADSL is now available as an unbundled service and this lowers the entry cost for any contender wanting to build market share.

4.2. Ireland: SERPANT (South-East Regional Public Access Network of Telecommunications)

The SERPANT Broadband Project came out of a national broadband strategy[24] devised by the Irish Department of Communications, Marine and Natural Resources in 2004.

At the time, then Minister, Dermot Ahern stated that he had "secured government funding until 2007 which will deliver broadband to over 350,000 people who simply cannot get it at present." [25] The initiative targeted 88 towns with populations between 1,500-17,000 but mostly at the lower end of that population range. At the time, Ahern said the purpose of the initiative was to defend and develop Ireland's global competitiveness:" Ireland has to maintain its premier position as a supplier

of digital goods and services to a global market. High-speed, low cost broadband helps ensure this."

Under the same nationwide broadband initiative, the Ministry offered 40 per cent of costs to rural communities who wanted to set up Group Broadband schemes and also set up Esat (BT Ireland) to provide high-speed backhaul links to regional providers embarking on initiatives like SERPANT. Nationally, the Ministry allocated 140 million Euros over a three year period, a significant part of which came from the European Union as part of Ireland's National Development Plan 2000-2006. In broad terms, the European Union funds are designed to benefit those areas that have not developed as well economically as other parts of the country.

In the case of SERPANT, primary responsibility was taken by a regional public authority, the South-East Regional Authority which covers the various local authority areas. As in the Stockholm example, SERPANT was set to fill a gap left by the failure of the private sector to roll-out broadband to these areas. The South East Regional Authority noted at its launch that "This move towards public ownership and provision of broadband telecommunications infrastructure is a new departure for regional and local authorities in Ireland and it represents a strategy to fill the gap in service provision that the private sector has hitherto failed to achieve". The proposed 26 metropolitan broadband rings seen as "major drivers of inward investment and cheaper communications links".

After a competitive bidding process, a local company, E-Net, was awarded a 15 year concession agreement to run the MANs constructed throughout the state. In formal terms, the role of e-Net is to operate, manage and promote the Government-owned metropolitan area networks that were built under the e-commerce measure of the National Development Plan. The network was built at a total cost of 18 million Euros and there is provision to extend the network beyond the local authority areas to a larger catchment area of customers.

A duct and optic fibre network passes as many businesses, government buildings, educational establishments and industry locations as possible. E-Net installs service connections between the main network and the customer premises. Spur routes have been provided for connectivity to certain key customers like major hospitals where a ring configuration could not be economically justified at the time. As elsewhere, the idea is to reduce the infrastructural investment costs that each service provider has to secure before being able to start offering broadband services to customers.

E-Net thus operates as a wholesaler of access to the metropolitan area networks and offers a full suite of products including ducting, sub-ducting, dark fibre, high level managed capacity, collocation facilities and relevant auxiliary services. It claims to offer pricing that is comparable with the cheapest available internationally.

Minister Ahern noted that the contract awarded to E-Net balanced public and private purposes, with the local authorities responsible for the capital risk and E-Net for the operational risks. He noted that "the contact strikes a balance between the more commercial objectives of the management company and the longer-term economic development objectives of the government and the local authorities." [26]

E-Net is headed by property developer Michael Tiernan of Tiernan Properties and funded by ACT Venture Capital, Anglo Irish Bank, Bank of Ireland and private equity. It has attracted industry expertise both at management and Board level from a range of companies.

4.3. United States: Mid-Atlantic Broadband Co-operative (Virginia)

Mid-Atlantic Broadband Co-operative (MBC) covers an area of rural south Virginia and was set up in 2000 in response to a range of problems caused by changes in the global economy. Entire industries such as tobacco, farming, textiles, furniture and more broadly manufacturing in general were disappearing, leading to thousands of job losses. The workforce had low education levels and old skills that were no longer required. Due to its geographic location, there were no competitive telecommunications carriers and services were expensive. Moreover, the existing carriers had no plans to roll out widespread broadband access in the region.

The idea for MBC was part of a broader economic development response to these circumstances and brought together business leaders, local university Virginia Tech and the Virginia Tobacco Commission.[27] This broader strategy aimed to transform the regional economy by creating a unique competitive advantage. The solution was a development strategy with four key pillars that were to build: an open access telecommunications infrastructure; human infrastructure; the conditions for innovation and regional development capacity.

The initial hurdle to overcome was how to get 20 counties and four cities, each with their own agendas, ideas and different levels of knowledge of telecommunications to work together. Each of these organizations had to be convinced that it would be better and more cost-effective to build a single network rather than patch together both the funding and construction required.

Eventually a single entity – Mid Atlantic Broadband Co-operative – was set up to manage the project, oversee construction and provide the same infrastructure and network connections for each County and City. Total funding of USD48 million came from the Virginia Tobacco Commission (USD42 million) and the Federal Government (USD6 million). These grant dollars were used to offset the debt service payments on the capital costs thus making it easier to deliver a cost-effective service.

Figure 2: Multi-Media Service Access Points

- Collocation
- Connection
- 24-hour access
- Security
- QoS

Source: Mid-Atlantic Broadband Co-operative

The network was designed to connect all business and technology parks, even including some that were not yet occupied as an incentive for inward location to the area. MBC operates solely as a wholesale carrier and offers backbone services that anyone can use including existing carriers like

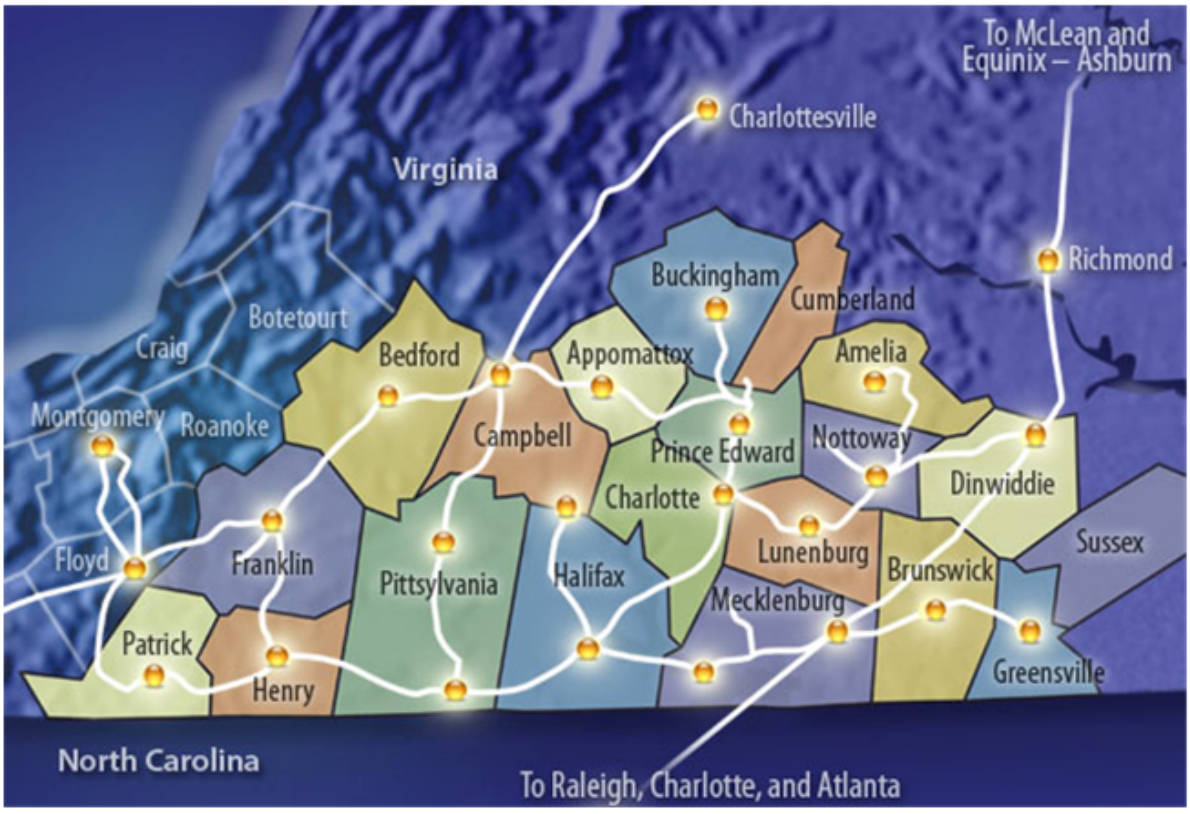
Verizon and Sprint. It offers dark fibre and also transport services in layers 1 (physical) and 2 (transport). Its philosophy is to make it easier for other service operators to serve the end user. MBC has laid over 1,100 kms of fibre and has 20 nodes that it calls Multi-Media Service Access Points (see Figure 2) with OC-48 and OC-192 backbone rings. Any service provider can sign a collocation agreement and put their equipment into one of its MSAPs. The agreement gives them 24 hour key card access and if the provider requires it, the equipment within the facility can also be located in lockable cabinets. All MSAPs are monitored remotely by cameras.

In return for obtaining rights of way, MBC gave 2 fibre strands to each of the local authority bodies which they could use for their own purposes, including for example, traffic sensor services. Overall it gave 12 strands of fibre for public sector use. In order to connect its network nationally and internationally, MBC has links to Tier one data locations, including Equinix in Ashburn, near to the capital Washington DC. It is also able to arrange cost-effective international transit for its users.

In the United States, there are several companies that provide towers for mobile providers to rent, again another pragmatic form of sharing. However, in this instance MBC has erected towers, which are connected to its fibre backbone, to create the incentive for mobile providers and wireless ISPs to supply both voice and broadband services, since its charges are much lower than competing tower companies.

Telecommunications companies join MBC as co-operative members and it provides open-access to its network, regardless of carrier, needs or competitive position. Member companies share in profitability of MBC through what are called Capital Credits at the end of each year. In effect, Capital Credits are a way of allowing for profit redistribution with a co-operative structure.

Box 2: Virginia Mid-Atlantic Broadband Co-operative (MBC)
Southside Virginia Coverage



Source: www.mbc-va.com/networkCVA.php

4.4. Other

Europe has a considerable number of FTTH projects initiated by local authorities. One of the largest of these initiatives is the City of Amsterdam and because of initial doubts stemming from the viability of the business plan and certain pre-investments carried out by the City of Amsterdam, the European Commission opened a formal investigation in December 2006. However, a year later the Commission concluded that the City of Amsterdam is participating in the project on the same terms as a would-be market investor. Therefore the Commission concluded that no state aid was involved.

Together with other shareholders, Amsterdam is investing in a company building a "fibre-to-the-home" broadband access network connecting 37,000 households in Amsterdam. The total equity investment in the project is 18 million euro. The Amsterdam municipality owns one third of the shares, two private investors, ING Real Estate and Reggefibre together own another third, while five housing corporations own the remaining third. The wholesale operator of the new fibre network was selected through a tender procedure and will provide open, non-discriminatory access to retail operators which offer TV, broadband and telephony services. Under EU state aid rules, investments by public authorities in companies carrying out economic activities can be considered outside of the state aid rules, if they are made on terms that a private investor operating under market conditions would have accepted (the market economy investor principle).

The European Commission has assessed over 30 public support measures for broadband services and networks under the state aid rules. If public intervention is well-justified because the market alone would not have provided the subsidized service, such as in rural areas with a low population density and no broadband coverage, state aid is generally considered to be justified. The Commission is more cautious when public authorities grant support in metropolitan areas, such as Amsterdam, where commercial broadband services are already available at competitive conditions. Such aid may crowd out existing and future investments by market players. However, in the case at hand, no state aid is involved, as the City of Amsterdam is acting like a market investor.

The City of Amsterdam is but one of many FTTH initiatives, including those that are being promoted by municipalities and power utilities in Europe. According to a presentation by an FTTH Council Europe Board Member, in June 2006 there were 84 projects being promoted by municipalities and power utilities, including the City of Vienna; Reykjavik Energy; Almere in the Netherlands and Vasteras in Sweden.[28]

5 POLICY AND REGULATORY ISSUES

The preceding sections of this paper have made numerous references to the enabling role of policy and regulation in the sharing of national infrastructure. At its simplest, this role is no different from the role played by policy and regulation in mandating any form of access regime, whether it is for interconnection, enabling facilities leasing or regulating access and pricing to essential facilities, or unbundling the local loop. Moreover, not only is the role unchanged, but the very tools with which to implement policy on infrastructure sharing are at the disposal of government and policy-makers and form part of any essential tool-kit on effective regulation.

Like all utility sectors, telecommunications access networks have historically had naturally high barriers to entry. The main barrier to entry was the cost of infrastructure provision. Laying down copper cable to individual households was a tremendously expensive undertaking. In most developing countries, the private sector did not have sufficient resources to meet the investment requirements of building telecommunications infrastructure. As a result, key infrastructure was either directly paid for by government (via state owned companies) or by private monopolies that were given a guaranteed rate of return and exclusivity conditions in order to repay their initial investment. Even then, the goal of providing household access to telecommunications was rarely

met. In the last few decades, however, technology has evolved and prices have reduced such that there are more operators willing to take the risk of building their own infrastructure, enabling telecommunications services to be provided on a competitive basis.

This has taken different forms. In the United States, for example, facilities-based competition was possible, even in the access market, since cable TV networks were widely deployed and could be cost-effectively upgraded to provide broadband services. In Europe, however, a second access network was not widely deployed. Europe, therefore, promoted a service-based competition framework mandating local loop unbundling to spark broadband access networks, in the form of DSL upgrades to the legacy copper networks.

What is not clear at this point in time is whether costs for fibre backbone networks in developing countries can be significantly lowered, through infrastructure sharing and other mechanisms, to foster facilities-based competition, or whether costs will remain too high relative to likely returns on investment, such that they can only be provided on a service-based competitive framework. Realistically, the answer may be very different for rural than urban areas. Will lifting regulatory restrictions to market entry by potential fibre backbone providers open the door to multiple backbone and backhaul providers (e.g., enabling entry by small or regional backhaul providers)? Or is the developing country fibre backbone market more likely to mirror the European broadband access market, requiring regulatory intervention to mandate its development? Only if both options are available will the answers to these questions ever be known.

Where key infrastructure remains difficult or expensive to build, and can, once regulatory burdens are lifted, be provided by a single or limited number of operators and cannot be easily duplicated either environmentally, technically or economically, such infrastructure is termed « essential facilities ». Since essential facilities are the backbone of a telecoms network, providing cheap access has immediate beneficial effects on the competitiveness of the sector and results in lowered pricing and increased penetration. Infrastructure sharing as a regulatory tool to address bottlenecks, limits the need for new entrants to duplicate networks and by so doing, facilitates more rapid deployment and optimizes investment by gearing it towards underserved areas, product innovation and improved customer services.[29]

5.1. Contextualizing the regulatory debate

In essence then, the regulatory conversation necessary on infrastructure sharing reflect the many conversations underway at national regulatory bodies in the form of policy discussions and consultations on various forms of access and pricing issues necessary to facilitate market entry, growth and further liberalization. Infrastructure sharing can also be viewed in the broader context of the increasing trend towards open access models which has been gaining momentum over the past few years. For the reasons associated with costs, replicability of assets, access to land, speed of market entry and the like, the generally supported view is that the concept of open access is vital to competition. As it has been noted, “underlying most of regulatory economics is the existence of problems associated with lack of competitive entry. It is this which makes markets fail or succeed.”[30] (see Box 1). As the trend towards open access gains momentum, it is clear that the technology exists to achieve national policy objectives but its successful deployment is subject to an enabling policy and regulatory environment being established and implemented.

Policy-makers and regulators need to carefully consider the policy dimensions, implementation challenges and monitoring and enforcement issues associated with ensuring competitive entry in their national markets. This is even more acute in some developing countries where competition is just commencing in the market and numerous challenges persist for service delivery from difficult geographies for ubiquitous wireless coverage, as well as difficult terrain for fibre construction. The possibilities created by the different modes of infrastructure sharing offer governments and regulators an opportunity to speed up competitive entry in their markets by reducing the capital

costs of operators generally associated with network investments. With reduced entry costs and faster speed of access, comes more incentive for new entrants to invest in new markets. While there are clear benefits to giving fair access to essential facilities, the difficulty for government and regulators lies in implementing a fair access regime.

5.2. Balancing Competition and Investment

While the regulatory concern is essentially one of "access", there is also a bigger policy debate that frames the regulatory response. At the heart of all access discussions lies a challenge for government and regulators to balance two complementary, yet often competing policy objectives: on the one hand, increased competition will facilitate better quality, more diverse services and better prices, and on the other hand, a favorable investment climate for those operators who have already committed significant capital expenditure is required and this must also ensure an opportunity to secure investment returns. While strong competition might be viewed by some as an inhibitor of investment, competition and investment are in fact, inextricably linked as the right investments also ensure that services and innovation evolve, which would not be the case where there is no competition. It is now widely accepted that the most effective mechanism to achieve affordable pricing and high penetration levels in any given market, is competition.[31]

Table 4: Barriers to entry: the ladder of investment for Broadband

A hierarchy of infrastructure assets can be developed based on the ease of replication of each asset. The aim of this hierarchy is to pitch regulatory intervention at the appropriate stage of infrastructure development and to create incentives that encourage operators to move up the hierarchy towards assets that are more difficult to replicate. A dynamic approach to regulation is needed as demand changes and costs vary according to innovation. This requires practical principles according to which levels of replication can be determined as well as a phased approach to implementing regulatory interventions and identifying at what rung in the ladder the most appropriate interventions will be. A balanced regulatory approach to access is necessary in order to ensure that the benefits of competition and innovation are available to consumers.

Local Loop	Least replicable by an identical asset network, particularly in countries that lack cable access	**Hardest (non-replicable)**
DSLAMs	Competitive suppliers renting loops have to install DSLAMs and collocate in the incumbent's exchange. Feasibility and ease is controversial. Cost modeling suggests a minimum efficient scale, high in relation to the number of broadband subscribers on any exchange. Scope for replication will vary within different countries	
Backhaul	Replication heavily dependent on geography	Relative ranking of ease of replicability
IP Network	High degree of replicability as network operators are able to attract more traffic or a more central location	
Retailing	Not susceptible to cost modeling in the same way as network service supply. Price regulation to leverage arbitrage to embark on the "ladder" will have no value for infrastructure competition	**Easiest (Replicable)**

Source: Cave, *Telecommunications Policy, 2006*

This however, requires a clear policy from government evidencing political will to bring about the conditions required for competition to thrive. In many cases within the telecommunications sector, this does not even require that positive actions be taken to stimulate competition, but rather, that

existing legislative and regulatory barriers to more effective competition, simply be removed. Invariably, underlying many of these barriers are problems associated with the "incumbent legacy". It is generally understood that due to the difficulty of duplicating infrastructure, new entrants are disadvantaged by not having access to infrastructure that was paid for some time ago under monopoly conditions. Incumbents have an incentive not to give fair access to infrastructure in order to protect their own revenues and the inefficiencies associated with being a former monopoly. Providing access at fair prices (usually some form of cost based provision) allows for innovation by new entrants, particularly in service provision. Since essential facilities are the backbone of a telecoms network, providing cheap access has immediate beneficial effects on the competitiveness of the sector and results in lowered pricing and increased penetration. Discriminatory practices by incumbent operators that prevent competition, usually by frustrating wholesale access to bottleneck facilities, have to be curtailed. The open access model is gaining momentum as a potential solution to the problem of ensuring that new entrants are able to enter a market that exhibits high structural barriers to entry.

While there are some generally agreed upon principles for approaching these challenges, there is no simple choice between open access (competition) and exclusive access (investment returns) and a balance between the two options thus needs to be carefully constructed. Striking the right balance requires the government and the regulator to take a dynamic approach to market analysis in order to make decisions appropriate to the level of both competition and investment in that particular market. A static approach, or where the regulator lacks the resources to dynamically monitor the market, increases the risk of adopting the extreme of either open or exclusive access which could result in a stultifying investment climate: either the incumbent sees no reason to invest in new infrastructure, or new entrants see no reason to risk investment in infrastructure to which they already have guaranteed access.

This paper advocates a middle path by suggesting a dynamic balance of policy objectives against the needs of the market. It also requires that the role of the government as player and referee needs to be carefully examined. Implicit in this is recognition by the policy-maker or regulator that while an impartial referee in theory, it is also a player and stakeholder in the sector and that its regulations or access regime (or lack thereof) have an impact on investment decisions by the market.[32]

5.3. Regulatory and Policy Imperatives of infrastructure sharing

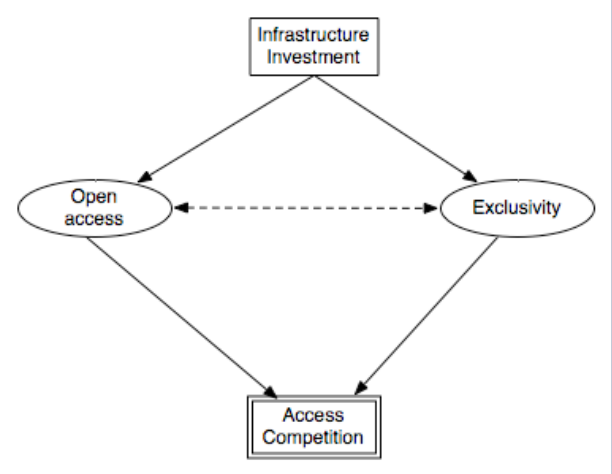
While there is variation within and between countries at different levels of development, the general regulatory/policy imperatives are the following:

Investment Incentives– The key challenge to be addressed here is how the regulator or policy-maker ensures that there are adequate incentives within the regulatory framework for operators to invest and continue to invest in infrastructure. This means that conditions must be created wherein infrastructure that is not easily replicable is still being rolled out. At the same time, it will require that access to this infrastructure exists. As a result there is an inevitable tension between the equally important policy objectives of open access and investment. Open access must entail some loss of return for the owner of the infrastructure if prices are regulated.

Open Access – Along with the principle of non-discrimination, open access is important because it lowers the barriers to entry of new entrants. The key problem is to provide competition at all (or most) levels of access because this has direct benefits in terms of innovation, specifically new technologies being introduced into the market, lower prices and wider penetration. In this regard, as access can be given at any of the layers discussed in Table 1, above, regulators need to ensure that if licensing is required, there is a regime in place that is capable of addressing access at any of these levels.

Open access thus becomes a tool with which to create infrastructure investment and facilitate new entrants and competition. However, as noted earlier, the overall challenge becomes one of guarding against abuse of the regulatory tool (open access) and if too much access is given to new entrants, the result can in effect be the same as when there is exclusivity on infrastructure access – namely, that there is little or no investment in infrastructure. An example of this is the market in the United States between 1996 and 2002. The reason that there was so little investment in (local loop) infrastructure by new entrants was that they could not supply infrastructure at the regulated prices – the prices were far too cheap, thereby acting as a disincentive to investment.

Figure 3: Policy Challenge – balancing open access and exclusivity



In the above diagram, the dotted line between open access and exclusivity represents that tension between the two options available to regulators or policy-makers. The traditional approach has been to provide the incumbent with an exclusivity period, during which it is obligated to rollout infrastructure. In nearly every case this policy has failed. However, there is also no point in a regulatory policy that allows the other extreme of providing access that acts as a disincentive to investment. As such, a regulator must adopt a dynamic approach that takes changing cost factors, technological innovation and the stage of competition at each level of access into account.

Regulatory Tools - The key challenge is not to reinvent the wheel. Governments, policy-makers and regulators in the telecommunications sector have been grappling with access regimes for the last two decades as deregulation and liberalization trends have increased. The means with which to effect this are all within current practices and processes underway. As discussed above, these include interconnection rules on access, pricing and dispute resolution; access rules for local loop unbundling and mandating access to bottleneck or essential facilities. There are some clear principles that may be followed: There should be a clear link to the definition of essential facilities - where are the bottlenecks and is it possible to provide alternative infrastructure at this point? In other words, is the specific infrastructure economically, environmentally or technically duplicable? One of the most commonly cited examples of essential facilities is the local loop. The conclusion in nearly all countries at this point in time is that it is not possible to duplicate this infrastructure and therefore it should be declared an essential facility. Because of the historical role that governments have played in providing essential facilities, a political commitment to lowering the barriers to entry (and therefore allowing access by new entrants) is also vital.

5.4. Implementation Considerations

To move the debate on implementation beyond the broad principles of non-discrimination, regulators need to identify and remove any technical constraints to infrastructure sharing. The following principles are of importance:

Commercial Imperative: Arrangements for the sharing of infrastructure between operators should be guided and shaped by an enabling regulatory and policy framework but as far as possible, allow for commercial negotiation. Sharing arrangements should be made on the basis of access-seeker arrangement but general agreement principles and time limits should be specified for concluding agreements on the sharing of infrastructure. In India, TRAI has required that service providers announce a program of passive infrastructure sharing on the existing infrastructure (where feasible) and for future investment while setting up mobile towers. TRAI also requires that sharing should be offered to other service providers on first come first serve basis subject to commercial agreements. Policy makers/regulators might also simply list and identify critical infrastructure sites without any further policy intervention.

Non-discrimination and Transparency: discrimination can take the form of price discrimination, (where the incumbent prices access for competitors in a manner which precludes competition with the incumbent) and non-price discrimination, (access terms and conditions which are less favorable than those it provides to itself or subsidiaries). Ensuring non-discrimination and transparency in access terms and pricing is a core function of regulatory interventions. This means that new entrants and service providers should have access to the full range of co-location and connection services, possibly if necessary, at a regulated price. The key point is to provide access to the network at different levels. Open access is not an all or nothing concept. There are gradations of implementation and the innovative ways that LLU (as a form of infrastructure sharing) has been implemented show a clear glide path towards higher levels of open access. Therefore, the technical constraints are generally more complex the more difficult the level of duplication is. In its recommendations on infrastructure sharing, TRAI has not mandated how passive infrastructure sharing should take place, but has required that the entire process should be transparent and non-discriminatory. Licensees must publish on their websites the details of existing as well as future infrastructure installations available for sharing by other service providers.[33]

Technical Feasibility: Access at different layers in the network raises issues of technical compliance and feasibility. All too often regulators must decide on interconnection disputes that have at their root, contestation over technical feasibility. Some of these claims are not without merit and in such cases, policy intervention may not yield the desired results. In the mobile market for example, much of the present infrastructure was created for utilization by specific operators themselves. Many towers erected in the initial stages of network roll-out were not designed with the possibility in mind of sharing with other operators. In the design of fibre networks, there is a view that PON networks (point to multipoint) for example, are not really designed for sharing, most particularly video (See Section3.1 above on technical sharing). Vendors often seek to push the roll-out of these networks in developing countries so that they can re-assert their control over the infrastructure network and in so doing, go back to making high margins. However, the imperative of open access means that anyone can connect to anyone in a technology-neutral framework at any level within the network.[34] Regulators thus need to guard against denial of access arguments on the basis of technological non-feasibility as a tactic to inhibit competition. Where there is merit to arguments of technological feasibility, those countries which have yet to deploy fibre networks should ensure that policy requires deployment of networks which are capable of open access. Moreover, the examples included in this paper demonstrate that open access of fibre networks is not only feasible, but is already being done.

Pricing: There are different forms of pricing options that can be explored and some type of cost based metric is considered best practice. This will vary from country to country but requires significant resources from regulators to ensure that it is implemented correctly. It may also be

prudent to explore an option pricing approach which means that prices for the use of infrastructure start low to give new entrants a leg up initially, but over a period of time become progressively more expensive. The incentive here is ultimately for the new entrant to build its own infrastructure in those parts of the network that are replicable rather than having to pay higher and higher prices. It is however critical that any pricing methodology allow for a reasonable rate of return to ensure continued maintenance of the infrastructure – there is no point to mandating pricing below the cost of provision.

Competition Policy: Dominance or Significant Market Power (SMP): Policy to achieve development in the telecommunications sector and in the promotion of competition can be developed based on the lessons – both positive and negative – of countries at different stages in the process. The policy chosen will depend on the level of market maturity and the degree of liberalization. A comprehensive framework for managing anti-competitive conduct will however be required to ensure no abuse of market power or dominance where the owner of the infrastructure also competes downstream with other service providers in the same market. Such policy should incorporate an implicit understanding that regulatory or policy intervention is usually only mandated where there is a presence of SMP and an abuse of dominance in that market. The standard metrics for best practice regulation, including proportionality, narrow application and targeted interventions should apply equally with respect to managing competition issues arising from the sharing of infrastructure as they do with regard to other areas of price, access and competition regulation.

Enforcement: In line with the above, no policy can however, be effectively achieved without a sound enforcement framework in which complaints can be brought and disputes resolved with respect to the policy to share national infrastructure. Prescribing the form such enforcement should take on a universal basis is not possible as each country has its own institutional endowments and legal frameworks which may differ. The common thread however is a solid and effective mechanism for complaints handling and enforcement of policy with sanctions for violation sufficient to create incentives to comply.

Incentive Creation: Markets respond well to commercial incentives. One policy consideration is the creation of a financial incentive scheme for operators to make it commercially beneficial to share infrastructure. In the functional separation context, BT's allowable 10 per cent investment return on network assets is an example. Other such incentives could include for example, regulatory exemptions; financial subsidies; reduced charges from civic or local authorities for installation of infrastructure where applicable; reduction in taxes and levies when a site is shared by service providers; a subsidy scheme or reduction in license fees. Regulators could also consider the award of more spectrum to operators sharing infrastructure. It could however be argued that there is no need for any financial incentive to be created by the policy-maker/regulator for infrastructure sharing as the very fact that it would result in reduction of Capex and Opex for all concerned parties will serve to encourage the sharing arrangements.

Role of Government: In the promotion of an open access model, the government needs to take a firm policy position on its role in the sector. Historically, in most developing countries, there is a legacy of state ownership in incumbents and a current practice of some form of equity retention even where liberalization policy is being implemented. While seeking to ensure consumer welfare and access, the government needs to decide if its role is to promote innovation, affordable pricing and high penetration, or to act as an economic stimulant in the form of active involvement (and ownership) in the sector? Evidence however, tends to warn against state involvement in the sector as both a market player and policy maker.

5.5. Unbundling as a form of infrastructure sharing

Unbundling of the local loop (LLU) specifically is an alternative way in which some the goals of infrastructure sharing – as a form of sharing- can be achieved. There are various ways in which to unbundle the local loop. These include full unbundling;[35] line sharing[36] and bit stream access.[37] The European Commission Regulation on Local Loop Unbundling (EC/2887/2000) came into force on 2 January 2001. This requires incumbent operators throughout Europe to offer unbundled access to their local loops on reasonable request. The Regulation also requires the incumbents to offer shared access and sub-loop unbundling or bit stream access.[38] Various developing countries such as South Africa, are examining the option of LLU to increase competition in their markets and countries like Morocco are already seeing significant gains as a result of this process.

The choice of model or combination thereof will be informed by different market circumstances and objectives. There is no reason why the same range of unbundled products offered on copper networks (raw copper, bit stream, line sharing, etc) would not apply in a fibre environment although there may however be slightly different considerations that arise from the much higher bandwidth capabilities. Moreover, if the fibre is located within a next-generation network (NGN) access network, with new intelligence and guaranteed quality of service built in, there are software/intelligence unbundling solutions that might be explored in addition to access to the physical network elements. These solutions would form the initial part of access until there were competitive options available to resellers. The argument that duplication is economically inefficient has been removed by the fact that allowing entry (and exit) from the market under competitive conditions means that the decision to invest is made by the firm and not by the regulator or by government. In essence, the point is to allow the "invisible hand" of the market to act by creating a level playing field and removing structural barriers to entry, particularly those created by the incumbents.

With respect to fibre backhaul in developing countries for broadband wireless networks in rural and urban areas, it does seem evident that some backhaul is replicable, dependent upon geographical and population density variables. This might include the regulator implementing the principles of a standard interconnection access regime as interconnection issues would remain pertinent.

The major regulatory limitations remain the challenge of harnessing and maintaining the resources to monitor the stage of competition in each level of infrastructure access but as a template approach, the issues the government and regulators might consider addressing by way of agreement principles for the terms and conditions of access/sharing, include:

- *Non-discrimination* among similar requests and no more favorable treatment for affiliates of the network operator
- *Quality of Service:* seamless transmission of any communications and testing and maintenance, fault reporting, service level disputes, system protection and safety measures
- *Service level agreements* that also provide reasonable remedies and penalties for any failure to meet those service levels
- *Standardization* with all relevant standards of the ITU and other technical standards
- *Confidentiality* of customer information
- *Transparency* such that charges for network elements are sufficiently unbundled and in line with any pricing methodology specified by the regulator
- *Billing and settlement* procedures and means of settling disputes
- *Charges* and mechanisms for the review of component charges
- *Enforcement* provisions and offences and penalties for contravention
- *Dispute resolution* procedures

Box 4: Infrastructure sharing in India: an imperative for sustained telecom growth

TRAI, the regulator in India, has sought to foster cooperative efforts amongst operators in India by making recommendations regarding passive and active infrastructure sharing and backhaul to enable further growth in mobile services, particularly in rural and remote areas. These recommendations follow a public consultation process. Given the significant costs of infrastructure investment, TRAI has acknowledged the need to optimally utilize available resources while ensuring competition and availability of services at affordable prices. TRAI has noted that infrastructure sharing can reduce costs and leverage roll-out of services more cheaply and quickly. It can enable more rapid coverage in the start up phase and in the longer term more cost effective coverage in un-serviced areas. TRAI has noted that regulatory interventions should only follow other policy initiatives including financial incentives. TRAI's policy recommendations include the following:

- Passive infrastructure sharing be subject to financial incentives – all licensees in any service areas will qualify for financial subvention schemes meant for rural areas;
- Tax exemptions of earnings from infrastructure sharing could be considered;
- Terms of sharing to be decided by commercial agreement between service providers but TRAI has reserved the option of prescribing a standard commercial agreement format in the future;
- A Joint Working Group will be established with representatives of operators, service providers, municipalities, local authorities and the Military Land control wing to assist in the resolution of disputes;
- Critical infrastructure sites will be identified;
- License conditions will be amended to allow active infrastructure sharing limited to antenna, feeder cable, Node B, Radio Access Network and transmission systems;
- To allow service providers to share their backhaul from the Base Tran receiver Station (BTS) to the Base Station Controller (BSC) as optical fibre in urban area is mostly available but it is not being optimally utilized;
- Sharing is permitted on optical fibre as well as radio at certain nodes;
- No sharing of spectrum at the access network has been recommended;
- Explore alternative, non-conventional energy sources to address critical power availability concerns.

Mindful of this tension between mandating access and encouraging ongoing investment, TRAI has attempted to ensure that such initiatives do not impact the competition in the market and in no way reduce the growth of wireless services in the country.

Source: TRAI, 2007

Whether sharing is used as a time-limited tactic or a long term strategy, it is necessary for regulators to have powers to impose the sharing of infrastructure in certain circumstances. As a paper from the French regulator ARCEP makes clear, this power will allow regulators[39]:

- To reduce interconnection conflicts between operators and oblige them to co-operate
- For both new entrants and small operators, it allows them to compete on a level playing field as quickly as possible
- It lowers one of the key barriers to market entry and thus significantly increases the opportunities for competition
- To encourage the growth of new service offers.

6 BEST PRACTICES FOR NATIONAL INFRASTRUCTURE SHARING

Given the multiple ways in which infrastructure sharing can be undertaken and how varying levels of market maturity and investment imperatives will affect these decisions, it is difficult to give a template "best practice" for implementation. In addition, in some countries, the regulatory functions rest with the policy makers, in which case the principles outlined below can be adapted to the entity responsible for implementation. Some guidance may be offered as a starting point as follows:

National policy-makers need to:

- Decide on the direction of the market and impose enabling laws and regulations that can facilitate the build out of national infrastructure. This could include revising licensing and authorization policies to enable joint ventures and cooperatives and other non downstream market players that offer open access;
- Co-ordinate with other government departments to ensure that where possible, a country's infrastructure (for non telecoms purposes), is leveraged to facilitate telecommunications network deployment;
- Design policy to speed up increased infrastructure investment.
- Reflect the political will to enable change through clear, directed, proportional regulation that will bring about the desired outcomes;
- Where there is an absence of market players, design incentives that will direct investment into infrastructure in under-served and non-served areas through for example, tax exemptions or rebates;
- Consider policy that will separate retail and wholesale functions within national infrastructure providers;
- Act as a clearinghouse for rights of way approval.

Local Government bodies need to:

- Where responsible for rights of way, assist operators with facilitating rights of ways and access to ducts and poles;
- Set up a clearing point for rights of way if multiple agencies are responsible for rights of way at different parts of the network;
- Provide information such as site surveys and geographic information systems for public land;
- Speed up the processes for granting rights of way;
- Reduce the costs to operators for obtaining rights of way;

Regulators need to:

- Where access regimes do not currently allow for sharing, embark upon consultation processes to assess the market and where intervention would be most appropriate, directed and proportional;
- Implement licensing/authorization frameworks to allow open access providers and create incentives for those who have spare capacity on their networks to share that capacity;
- Design regulatory interventions that are based on the technical reality of access at multiple levels of the network;
- Create incentives to promote infrastructure sharing on commercial terms;
- Improve transparency requirements for operators to publish relevant information for infrastructure sharing;

- Decide whether to approve or require publication of reference sharing offers covering issues such as provision of collocation space and connection services, power supply, air conditioning, access to collocation facilities for maintenance, etc.;
- Establish where bottleneck facilities are and whether it is economically, technically or environmentally possible to duplicate such facilities;
- Where necessary, establish the cost methodology (cost plus a fair rate of return) upon which access is going to be mandated;
- Where the regulator is not responsible for rights of way, establish who is responsible and assist operators coordinate the complexities associated with dealing with multiple agencies; Establish sound monitoring and enforcement for implementing infrastructure sharing, including speedy dispute resolution among operators;
- Require the publication of reference interconnection offers (RIO's) or similar instruments by operators with significant market power that specify the terms of access; sub-licensing if necessary; charges, billing, dispute resolution, etc.;
- Use competitive bidding processes or auctions when authorizing municipal or backhaul providers;
- Coordinate the trenching and ducting works between operators and service providers. And provide mechanisms for monitoring duct upgrading to ensure that service providers remove obsolete cabling to allow the introduction of third-party fibre;.
- Publish a list and identify critical infrastructure sites (with or without any further policy intervention, as the case may be);
- Establish a Dispute Resolution mechanism for addressing disputes that might arise.

Industry players need to:

- Assess the business case for sharing, rather than duplicating infrastructure;
- Move away from the assumption that excluding access to network elements is the only way to secure revenue;
- Co-operate with regulatory/policy processes;
- Improve transparency and publish on their websites the details of existing as well as future infrastructure installations available for sharing by other service providers;
- Implement regulatory coordination of trenching and ducting works between operators and service providers and those of other utilities.

7 CONCLUSION

This Discussion Paper has attempted to highlight the key issues involved in extending open access to national fibre backbones with a focus on developing countries. There are relatively few cases globally where this is currently occurring. As such, few examples suggest of definitive statements at this time, but all – even at early stages of their operation - offer some lessons for countries seeking to adopt an open access model to national infrastructure sharing. While the paper has advocated a technology neutral approach, there are however, distinctions relating to the sharing of fixed line and wireless networks due to their physical differences. Many countries may have legacy networks that can be upgraded to support broadband, whether cable TV, microwave or copper. Yet, many other countries might not have any legacy networks which are capable of upgrading for this important policy goal. Numerous developing countries now seek to pursue an ICT development agenda that will leverage their existing legacy wireless access networks by upgrading to some kind of 3G, BWA or 4G technology, which will also require upgrades to the backhaul and backbone networks.

Provided the framework is correct and the right incentives are established, there is a great leapfrogging opportunity for developing countries to enable the deployment of national fibre

networks. The paper has also stressed that most of the regulatory and policy tools required are already available and need minor augmentation and adaptation. The paper has attempted to highlight these tools and draw some lessons for their "best practice" implementation. This paper is however ambitious in scope and content as it attempts to cover various scenarios in which national fibre sharing may occur, from the legal entity to the regulatory remedy. It has been noted however, that the most critical factor identified is the political will within government and regulators to enable the sharing of national fibre. With this secured, the implementation of law and policy that will give effect to these goals will be simpler, more efficient and effective.

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[4] Infraco has been established through an Act of Parliament and by way of an amendment to the sector legislation with the stated aim of empowering government to make strategic interventions on infrastructure investments whenever it deems it necessary. By doing so, government intends to enable itself to initiate government intervention to ensure strategic ICT infrastructure investment and thereby more easily be able to address the challenges of reducing the cost to communicate by providing infrastructure to other operators at wholesale rates; improve on government service delivery and support the country's economic policy; link Nepad/Broadband with Africa/Latin America and Europe and provide the much needed bandwidth for strategic projects and consumers in general

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[7] ITU World Telecommunication/ICT Indicators Database 2008.

[8] When looking at the case of two specific mobile operators in the MENA region, savings of USD 250 million over a period of 3 years can be expected should these operators decide to join forces in deploying their respective networks, See Booz Allen Hamilton Inc,"Telecom Infrastructure Sharing – Regulatory Enablers and Economic Benefits", November 2007 at www.boozallen.com/media/file/Telecom_Infrastructure_Sharing.pdf

[9] Booz Allen Hamilton Inc,"Telecom Infrastructure Sharing – Regulatory Enablers and Economic Benefits", November 2007 at www.boozallen.com/media/file/Telecom_Infrastructure_Sharing.pdf

[10] See article in Economic Times, 26 April 2007: http://economictimes.indiatimes.com/Broadband_to_go_free_in_2_yrs/articleshow/1955351.cms

[11] ICT Regulation Toolkit, New Technologies Module, Section 2.2.2, Network Innovations, Optical Fibre Networks www.ictregulationtoolkit.org//en/Section.1787.html

[12] See www.arcep.fr/fileadmin/reprise/communiques/communiques/2007/slides-confpresse-ftth-281107-eng.pdf

13 See also www.cipaco.org/spip.php?article1127

14 Guidelines on Collocation and Infrastructure Sharing Issued by the Nigerian Communications Commission, at: www.ncc.gov.ng/RegulatorFramework/Guidelines%20on%20Collocation%20&%20Infrastructure%20Sharing.pdf

15 See www.arcep.fr/index.php?id=8571&L=1&tx_gsactualite_pi1[uid]=964&tx_gsactualite_pi1[annee]=&tx_gsactualite_pi1[theme]=&tx_gsactualite_pi1[motscle]=&tx_gsactualite_pi1[backID]=26&cHash=c83e57282b

[16] Schedule 5A, Licensing of Lead-in Duct and its associated lead-in manholes at www.ida.gov.sg/Policies%20and%20Regulation/20060602171047.aspx

[17] TRA, Statement on Innovative Infrastructure Sharing and Open Access Strategies, at www.tra.gov.lb

[18] See www.itu.int/ITU-D/treg/projects/itu-ec/Acts_E.zip

[19] See www.itu.int/ITU-D/afr/events/FTRA/Nairobi-2007/Documents/Presentations/Session2/Poolsaar.pdf

[20] Paul Vecchiatto, "Telecoms policy a 'mistake'", itweb.co.za, 15 June 2007.

[21] See www.stokab.se/templates/StandardPage.aspx?id=306

[22] Government Bill 2004/05:175

[23] To achieve remote meter reading for different household services.

[24] The South East Information Society Strategy was launched in 2000 by the South East Regional Authority.

[25] Department of Communications, Marine and Natural Resources (Ireland) "Broadway – Regional Broadband Programme – Connecting a Global Community", January 2004 at www.sera.ie/docs/Broadway%20Spring%20Issue%20%20.pdf

[26] Ibid.

[27] The Tobacco Indemnification and Community Revitalization Commission is its full title and it redistributes money to the local authorities in its area that is given by the tobacco companies as a result of Court action over the dangers of tobacco products.

[28] Presentation by Ramil Houbby, Board Member of FTTH Council Europe at the One Optical Network Europe Conference, 24-25 September, Cannes, France

[29] Booz Allen Hamilton Inc,"Telecom Infrastructure Sharing – Regulatory Enablers and Economic Benefits", November 2007 at www.boozallen.com/media/file/Telecom_Infrastructure_Sharing.pdf

[30] Martin Cave, Encouraging infrastructure competition via the ladder of investment. Telecommunications Policy 30 (2006) at p. 226.

[31] "A commonsense appraisal of real-life experience – the comparison of productivity growth in countries with and without competitive market systems; Microsoft's efforts to use its dominance of the PC operating systems market to deny potential competitors access to related markets and to venture capital; the rapid introduction of new electric generating technologies when competition was opened up in the electricity market; the innovative services offered

by the airline industry when competition replaced regulation; the flood of innovations when the monopolies of BT in Britain and AT&T in America were successfully challenged – all suggest that competition means a fiercer gale of creative destruction of old technologies than does the cosier world of cartels and monopoly". See, I. Stelzer, "Creating an environment for rapid innovation" in Richards, E. Foster, R and Kiedrowski, T. 2007. Communications, the next decade. OFCOM, p.143.

[32] Academics at MIT have noted this concern as follows: The choice of layer in the network architecture for unbundling has important implications for allocation of costs and responsibilities between the bottleneck provider (in this case, a municipality) and the service providers, and for the range of services that can be offered by providers and the type of choice experienced by end-users. "While Layer 3 unbundling appears to support the most dynamic range of customer choice and flexible service-level competition, it also requires the municipality to become a full-fledged facilities-based provider of finished wholesale telecommunications services and limits the scope of facilities-based competition. Unbundling at lower layers reduces the municipalities' investment and role, and expands options for facilities-based competition for those elements of the local infrastructure that are not "bottleneck" facilities. Identifying where the bottleneck is likely to be in a world of changing technologies, market demand, and industry structure is difficult and uncertain, which helps explain the diversity of approaches." See, Lehr, W., Serbu, M., & Gillett, S. (2004) Broadband Open Access: Lessons from Municipal Network Case Studies", at http://itc.mit.edu/itel/docs/2004/Broadband_Open_Access.pdf

[33] However, indiscriminate non-discrimination might in the long run be as damaging as exclusive/proprietary arrangements. In this instance, there must be a regulatory requirement for technical feasibility and some reference to economic viability as a threshold for mandating access. This does however require careful implementation to avoid tactics by incumbents to keep new entrants out on the basis that sharing is technically not feasible or economically not viable.

[34] Infodev, 2005. Open Access Models: Options for Improving Backbone Access in Developing Countries (with a Focus on Sub-Saharan Africa).

[35] This method assigns the entire copper local loop to the leasing operator. New entrants will then install their own broadband equipment and collocate which would require the new entrants to place all the equipment in the incumbent's premises or outside the incumbent's premises depending on which collocation model is most appropriate.

[36] Line sharing is where the incumbent and other licensed operator share the same line. From the MDF the wires are connected to a splitter (which separates the frequencies for voice telephony and those for higher bandwidth services). The incumbent provides voice telephony over the lower frequency portion of the line, while another operator provides DSL services over the high frequency portion of the same line.

[37] This provides access to the bit stream on the network side of the DSLAM. In the case of copper circuit unbundled access the DSLAM connected to the unbundled circuit is always installed and operated by the new entrant. In the case of bit stream access, the DSLAM is installed and operated by the incumbent who also configures the DSLAM and sets up the required technical parameters (speed and quality of service (QoS) attributes) of each user's DSL access link. The output of the DSLAMs on the network side is configured as an Asynchronous Transfer Mode (ATM) transmission system.

[38] See http://europa.eu.int/eur-lex/en/lif/dat/2000/en_300R2887.html

[39] See www.art-telecom.fr/index.php?id=1&L=1