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Options for Improving Backbone Access in Developing Countries

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TABLE OF CONTENTS

INTRODUCTION

In late 2004, ***info***Dev commissioned a team from Spintrack AB of Stockholm, Sweden, to conduct a study titled "Leveraging New Technologies and Open Access Models: Options for Improving Backbone Access in Developing Countries (with a Focus on Sub-Saharan Africa)." The Spintrack core team working on the project included Anders Comstedt, Eric Osiakwan and Russell Southwood[1]. The study was completed in the summer of 2005.

During the course of the study, team members visited: Ghana, Kenya, Tanzania, Mozambique, and South Africa. They also spoke to Africans in many other countries who were at events the members attended during the study period. These events included: a United Nations (UN) information and communication technology (ICT) Task Force Meeting, the International Telecommunications Union (ITU) African Public-Private Partnership Meeting, GSM Africa, Internet Corporation for Assigned Names and Numbers (ICANN), the TRASA/CATIA Wireless Regulation and Policy Seminar, and the first African Voice-Over Internet Protocol (VoIP) Forum.

To keep a clear focus in the report, the study examines the leveraging of new technologies in relation to Open Access ideas rather than as a topic in its own right. It focuses on how, under the right circumstances, new and cheaper technologies can offer opportunities for low-cost market entry in developing countries. Therefore, the study does not include detailed descriptions of technology approaches except in Appendix A4.

This report has three main sections that are supported by supplementary material in the appendices and endnotes:

Section 1 looks at the kinds of obstacles that prevent the wider use of ICTs as development tools.

Section 2 examines how the obstacles might be overcome. It describes what an Open Access approach is and how it might be applied at different levels: local, national, regional, and international.

The report concludes by highlighting the implications of the approach for policymakers and regulators.

Section 3 examines how the different stakeholders - policymakers, regulators, international donors, and the private sector – might make use of an Open Access approach.

The appendices provide supporting material, including: a list of Background Reading (A1); a set of Open Access Principles (A2); Origins of the term Open Access (A3); technology approaches for small-scale rural operators (A4); municipal networks – background information (A5); and a Glossary of Terms (A6).

This study tackles some of the major difficulties experienced by developing countries by stepping back from day-to-day battles over policy and regulation. It attempts to see a way ahead through a flexible but holistic approach that will maximize the economic and social returns communications technologies can bring. It does not seek to provide a universal panacea but a set of ideas that can be applied in different ways in particular local circumstances.

This study is not intended to be the last word on Open Access but as a way of provoking a debate about how certain objectives can be achieved through policy and regulation. It will be an evolving debate that needs to draw in all those involved. This paper is intended as a contribution to that debate.

The primary focus of the study is Sub-Saharan Africa because we believe that Open Access ideas provide a useful way of overcoming some of the historic obstacles to providing greater access to communication in that region. However, the ideas may well be more broadly applicable and the degree to which they are will emerge from subsequent debate.

Although the study has recommendations, these have been kept at a fairly general level to avoid specific prescriptions becoming precise formulas for action. There are different ways of achieving the same ends in different circumstances, and it is important not to have yet another mono-dimensional set of approaches to complex issues. If on this basis the paper lacks precision in its recommendations, it is because those using Open Access ideas need to be able to reach conclusions that are appropriate to

1 The Project Director is Bjorn Soderberg and other team members are: Petter Lundkvist, Olof Hesselmark, Erik Eliasson, Johan Montelius and Johan Bilien.

their own circumstances: there is no policy kit with a single set of instructions.

This study is primarily designed to be read by national policymakers and their counterparts in donor agencies. It is written assuming some familiarity with the field but is neither an expert nor an academic paper. For this reason, much of the supporting evidence for assertions made in the study is in footnotes.[2]

The study's authors wish thank those interviewed who gave generously their time and ideas (particularly those in Sub-Saharan Africa). They also wish to thank Webopedia for the definition of terms found in the glossary in Appendix A5.

Finally they convey their thanks to all of those who commented on the draft version of this study: Mavis Ampah, Peter Lane Baldwin, Jerome Bezzina, Doreen Bogdan, William Kerr-Smith, Kerry McNamara, William Melody, Samia Melhem, Bjorn Pehrson, Susan Schorr, Peter L Smith, Mostafa Terrab and Charles Watt.

2 Because much of what is happening in Sub-Saharan Africa has taken place over the last year, many of these endnotes are not referenced to academic or consultancy studies. As there is a time-lag between what appear to be emerging realities and the capturing of what is happening, they are based on our conversations with players on the continent. In some instances, these include plans that can be described but cannot be more clearly identified for reasons of commercial confidentiality.

EXECUTIVE SUMMARY

"Open Access is about creating competition in all layers of the IP network (see diagram on opposite page) allowing a wide variety of physical networks and applications to interact in an open architecture. Put plainly, 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 ensure that no one entity can take a position of dominant market power. It requires transparency to ensure fair trading within and between the layers based on clear, comparative information on market prices and services. It seeks to build on the characteristics of the IP network to allow devolved local solutions rather than centralized ones.[3]"

Developing country heads of state have committed themselves to creating information societies as part of the World Summit on the Information Society (WSIS) process. Considerable energy is being expended both as part of WSIS and elsewhere to bring this about. For those involved in development – whether governments, donors or non–governmental organizations (NGOs) – ICTs are essential tools for delivering work in a number of important areas, including health, education, and e-government.

These ICT tools have the capacity to make information and services more widely available, thus improving the opportunities of the poorest in society. In order for these tools to be successfully used, all those involved in development require communications that are cheap and widely available, particularly in the poorer and harder-to-reach, rural areas.

ICT as a development issue is now high on the agenda but developing country policymakers find themselves frustrated by a policy and regulatory environment that is not yet producing the "step-change" required to address these issues in a productive way. Past circumstances have resulted in a mismatch between the desired policy objectives and the realities of the current moment: What might have happened before now no longer works.

A number of obstacles have prevented practical, effective action on the desired policy outcomes identified. These include: the dominance of the historic operator in policy discussions; the political difficulties of the privatization process; the reasons for resistance to the introduction of new, cost-saving technologies; the difficulties with providing universal access; the high cost of international bandwidth; and the difficulties of financing new, international infrastructure to lower costs.

Rather than continuing a fruitless debate over the details of what might have been, it is perhaps time to see whether there is another way of looking at how these obstacles might be overcome. If ICTs are to serve as tools for development we need to look at how it might be possible to provide easier, cheaper and wider access to them.

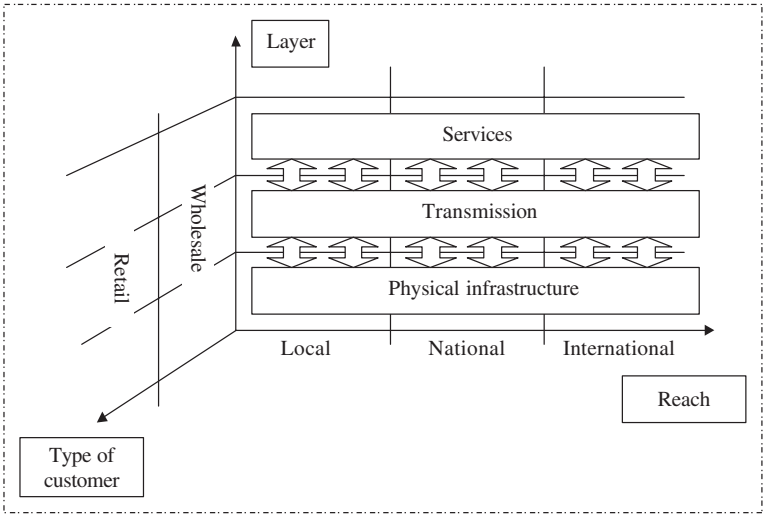
The gradual transition from circuit-switched networks to Internet protocol (IP) networks is creating a paradigm shift that is allowing the growth of decentralized services. It argues that IP network architecture – where the "intelligence" is located at the edge of the network – creates an opportunity to change the underlying structure, and thus the business model, of information and communications infrastructure and services.

The basis for these changes can be understood by looking at how those involved describe the operation of IP networks. Diagram 1 shows a Network Layers model. Essentially there are three key layers: physical infrastructure, transmission and services (including applications and content). In practical terms each layer has a set of functional rules that allow it to interface with the other layer and for information to flow over the network.[4] In terms of day-to-day reality, these network functions are combined with Reach (the geographic scope of providers) and Type of Customer (wholesale or retail).

The interface between layers is technically standardized by protocols and commercially agreed in Service Level Agreements and other businesses and contract commitments. The latter also tend to be standardized

3 Open Access as a term is used in several different ways and a brief summary of the origins of the term is provided in Appendix A3.
4 There are several more detailed ways of describing the layers and these capture what are essentially technical functions of the network. Applications include things like Web and mail browsers. Services include all forms of content whether voice, data or images.

DIAGRAM 1: Layered networks model



as the number of actors grows. For example, one player on the transport layer can rent fiber from several dark fiber providers to span its network and will need similar performance standards from each to simplify its offer to the service layer.

There are a number of market developments that will shape policy and regulation in the future. Two main trends are the separation of infrastructure and services and availability of "disruptive" technologies that offer the possibility of cheaper access to voice and data. These trends not only make possible, but create a strong rationale for, Open Access models.

Open Access is designed to create competition in all layers of the IP network allowing a wide variety of physical networks and applications to interact in an open architecture. Put plainly, 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 ensure that no one entity can take a position of dominant market power. It requires transparency to ensure fair trading within and between the layers based on clear, comparative information on market prices and services. It seeks to build on the characteristics of the IP network to allow devolved local solutions rather than centralized ones.

The "openness" creates a market dynamic at every level in the system, emphasizing the need to innovate in cost terms to expand the user base at a price and in a form appropriate to them. A diversity of services and physical infrastructure means that no single business model has to fit all users: smaller, lower cost operators can go where larger organizations might fear to tread.

Open Access focuses on lowering the cost of business entry but is "technology-neutral." The Open Access approach seeks to emphasize innovation that encourages providers to identify which technologies work at the right (lower) price: the technologies that are suitable will vary enormously depending on historic legacy equipment and physical circumstances.

Through Open Access, the market (with a gentle hand from the public sector) can begin to turn communication into a public good available to wider groups of people. Although Open Access places the effective operation of markets at its core, it acknowledges that the market will not deliver in all circumstances. It sees the challenge as extending communications to those at the bottom of the income pyramid by lowering the cost of services. In these situations the function of the public sector is to create the circumstances for successful Open Access (through partly funding infrastructure) and provide incentives for the roll-out of services as widely as possible.

At the rural level, Open Access emphasizes the importance of small-scale providers who can provide cheaper services than traditional operators because their entry and operating costs are lower. In an Open Access

environment, these "plug-and-play" operators have the potential to spread voice and Internet use to places currently not covered, while at the same time encouraging significant economic activity in rural areas.

At the national and city levels, Open Access emphasizes the importance of building networks that can help provide cheaper, lower-cost access to all users, particularly to government facilities such as schools and hospitals, and user-access points in poor, peri-urban areas. However the networks are built, and whoever operates them, the aim would be to connect an ever-widening base of users to the national infrastructure at prices that can become sustainable for all.

The key change would be for the historic operator to undergo a process of transformation that would allow it to emerge as the infrastructure provider. Depending on the history of the historic provider, this would be more or less difficult. The process will be relatively straightforward for historic providers that remain government-owned and set up operationally separate "business units" that are profit centers. But it will be more difficult for historic operators that still merge operations and cross-subsidize parts. If the historic operator has already been sold off in part or in whole, this may mean that the issue will have to be tackled in policy and regulatory terms.

Within this overall change, there would be a number of different options: a single, trusted nationwide infrastructure provider at all levels; trusted infrastructure providers at two different levels (national and district/municipal); or two competing infrastructure providers in every area, the alternative infrastructure provider using the assets of the utilities and railway organizations. The choice between these options is largely a function of scale but also might include considerations of governance.

At the international level, the Open Access approach emphasizes the importance of bringing the cost of international bandwidth down to cut the cost of communication for developing countries (particularly Sub-Saharan Africa), help spread national infrastructure, and encourage the growth of new global businesses such as call centers and outsourcing.

With an Open Access approach, government – at a national or local level – represents the public interest, particularly for the growth of the economy, and a social responsibility for the less well-off. It needs to act as a fair referee on competition issues and create a level playing field for providers. It also ensures that the interests of the users of the infrastructure (both consumers and service companies) are well represented in any governance mechanism.

In this new light touch role, government and the autonomous regulators that implement its policies have several key roles: to lower the barriers to remove as many unnecessary regulatory barriers as possible; to create a favorable business environment that offers investors enough certainty to develop their businesses and have a fair chance at a reasonable rate of return; and where necessary, to provide short-term "seed-funding" to encourage the risk-taking needed to expand the market.

There are also several important roles for the international donor community in helping to foster the expansion of affordable access through Open Access models, including policy dialogue and awareness raising; support for the transition from the historic incumbent operator; investment or risk underwriting for international and regional backbone infrastructure; and assistance with prototyping and piloting sustainable approaches in the most difficult environments, particularly poor and rural areas.

1. OVERCOMING CURRENT OBSTACLES

Developing country heads of state have committed themselves to creating information societies as part of the WSIS process, and considerable energy is being expended both as part of WSIS and elsewhere to bring this about. For those involved in development – whether governments, donors or NGOs – ICT is an essential tool for delivering work in a number of important areas including health, education, and e-government.

ICT tools can make information and services more widely available, thus improving the opportunities of the poorest in society. For these tools to be successfully used, all those involved in development require communications that are cheap and widely available, particularly in the poorer and harder-to-reach, rural areas.

ICT as a development issue is now high on the agenda. But developing country policymakers find themselves frustrated by a policy and regulatory environment that is not yet producing the "step-change" required to address the issue in a productive way. Past circumstances have led to a mismatch between the desired policy objectives and the realities of the current moment: what might have worked before no longer works.

The situation varies a great deal among developing countries. Some have approached a dead-end[5], while others face a situation that is full of promise but not yet accessible. Almost no developing countries have policy and regulatory environments that positively encourage the development of information societies at all levels. For donors, it is time to work with developing country governments to invest in projects that will open up development potential rather than reinforce a status quo defended by a variety of vested interests.

Because of the link between government ownership and the historic operator, policymakers are caught in a trap: on the one hand, they are inclined to protect their asset through decisions that do not disadvantage the historic operator.[6] On the other hand, they need to find ways of opening up the market to provide better public services. This tension has made independent regulation difficult to achieve. Governments and regulators often have a natural inclination to defend the status quo in the form of the historic operator as a "national asset."

The state of privatization in Sub-Saharan Africa

According to the ITU, only three historic operators were fully privatized in Africa, and 34 were partially privatized or in the process of privatization. The remaining 13 were state-owned. There have also been a significant number of "distressed" privatizations (most notably Ghana, Guinea-Bissau and Tanzania) where the new ownership has created a significant number of unresolved legal issues. In 24 out 48 Sub-Saharan African countries, the historic operator maintains a monopoly on international voice. Without privatization, governments lack the resources to invest in network development.

Although many governments have been able to articulate clear ICT policies, they have rarely been able to innovate or make decisive changes to implement their aspirations. In Sub-Saharan Africa, most governments no longer have the resources to invest directly in the historic operator to deliver on policy. They find themselves (along with their regulators) as referees of powerful institutional interests that often pit different government departments against each other.[7] The requirements for a successful ICT policy are not the same as the financial needs of hard-pressed governments.

5 This dead-end and the frustration it brings was described by the then Director-General of the Kenyan regulator (who is now MD of the historic operator, Telkom Kenya):"We have come from a regulatory environment that was dictated by – consciously or unconsciously – the protection of the incumbent's revenue. That obsession – even though its revenues fell anyway – was like trying to hold on to an illogical scenario."

6 The historic operator is the term used to refer to what might also be called the incumbent. In other words, it is the former public or private monopoly operator.

7 What the Ministry of Communications may want to achieve (wider access, greater competition) will not usually be compatible with the position of the Ministry of Finance (defending the asset value of the historic operator). This conflict could be seen at key points in the development of South Africa's ICT policy among others.

The historic operators are major employers, and large-scale redundancies[8] are nearly always the outcome of the transition from a state-owned entity to a profit-making company into which investors can put new capital.[9] There is an understandable political reluctance to address this issue. The historic operator represents a considerable opportunity for political patronage.[10] Yet many historic operators are effectively in a holding pattern.

A significant number of governments are delaying privatization, but do not have the money to improve to their operator's networks and other operations that would help maintain their assets. As a consequence, the physical condition of their networks is poor in many (but not all) cases. In the past, historic operators made financial contributions to government coffers, but now there is a significant number that are loss-making or only marginally profitable.[11] Government ownership of the historic operator dominates practical actions on policy and in many cases does not create the conditions for the growth of the market or for investment, either at a local or international level.

It can take months or years to get a fixed line for individual or corporate customers in Sub-Saharan countries where telecommunications have not been privatized. This situation provides ample opportunities for corruption, ranging from small-scale individual bribes to secure service, to instances of large scale call-diversion scandals.[12] In the private sector, where shortages are governed by how quickly the market can provide, no one pays bribes for services, and instances of large-scale corruption are few and far between. For example, no one pays a bribe to obtain a mobile phone anywhere in Africa. The level of corruption in some state-owned entities means both a significant lowering of their overall effectiveness as well as significant financial losses.

The first major step towards liberalization has generally been through the offering of mobile licenses. But despite the investment, efficient business practices, and energy they have brought, their impact has been limited as they have only been able (or wanted) to provide mobile telephony. They have met the demand for voice communications but have not always had much impact on infrastructure development, access to the Internet or data carriage, in particular for VoIP services.

While there has been competition among mobile operators in some markets, there are still many countries with only one or two operators.[13] After initial market entry, there is usually only a very narrow band of price competition between operator tariffs.[14] Prices for local mobile calls are between five to ten times higher than their fixed network equivalents. However, the costs of operating a GSM network are low in comparison with fixed networks, and the capital cost per user drops as the user base increases. When greater competition strips away the protected privileges of the historic operators, the mobile operators will in many countries emerge as the "new incumbents," becoming the largest entities (by value) in their markets.[15]

In a limited number of instances in Sub-Saharan Africa, the market has been opened to a Second

8 Often Governments give explicit instructions to management to avoid redundancies: Ghana Telecom and Nitel in Nigeria (where external management agents were employed) are two good examples. This makes the management task of creating a commercially healthy company extremely difficult and puts further pressure on historic operators to behave in an entirely defensive manner to all forms of competition. This in turn acts as a brake on the speed of future market development.

9 The Senegalese operator Sonatel, with roughly the same number of fixed line customers as Telkom Kenya, had only 2,000 employees compared to just over 17,000. PKF Consulting has recommended to Telkom Kenya that 12,281 of these employees should be laid off. On this basis, Telkom Kenya would still have double the employees it needs. The cost of making 12,281 employees redundant is according to the consultants somewhere between US$74-232.5 million and with pension costs included the figure rises to between US$146.8-304 million.

10 The scale of this patronage can most clearly be seen in the historic operator Telkom Kenya which has 3,052 watchmen, messengers and porters.

11 Although few historic operators operate with transparent accounting procedures, the following countries have historic operators that are either loss-making or marginally profitable: Botswana, Cameroon, Congo-Brazzaville, Ethiopia, Ghana, Guinea Bissau, Kenya, Liberia, Malawi, Mozambique, Nigeria, Sierra Leone, Tanzania, Zambia and Zimbabwe. This list includes a number of countries where the historic operator is not generating sufficient resources to invest in its network. This pattern mirrors that found in the developed world where the stock value of the 10 largest historic operators worldwide has steadily declined.

12 In 2003, then NITEL CEO said that 30-40% of internal revenues were lost through fraud. Before he was dismissed, the former Director of Licensing, Compliance and Standards of Kenyan regulator CCK described a fraudulent call-diversion operation uncovered in 2003 as a "mini-Telkom Kenya." There are a significant number of other instances of major fraud in historic operators but they have not been publicly identified.

13 In mainland Sub-Saharan Africa, there are 20 countries out of 32 that have two operators or less and seven that have only three operators. There are no Mobile Virtual Network Operators (MVNOs) although Botswana has expressed interest in attracting a third operator on this basis and Virgin Mobile will work with Cell-C in South Africa and may get involved with V-Mobile in Nigeria.

14 There are a bewildering array of time-limited sales promotions that lower prices temporarily but there is usually less than a 5% spread in published tariff prices, even where there are 3 operators (for example, South Africa). At the other end of the range, in early 2005 in Botswana, there was almost no difference between the published tariffs of the two operators.

15 One implication of this shift is that it may change who takes the lead in terms of the roll-out of national infrastructure. Some mobile companies (Celtel, MTN) have been involved in developing infrastructure whilst others have been significantly less involved. The key question is will a network built to respond to mobile customer needs be adequate for other requirements? The spread of GPRS and 3G implementations (Ghana, Kenya, Nigeria, South Africa, Tanzania, Uganda thus far announced) may go some way towards answering the question but the long-term success of these implementations has yet to be proven.

National Operator (SNO).[16] Where they exist, SNOs have nearly always mirrored the vertically integrated structure of the historic operators, while seeking to focus on the more lucrative markets available in their country of operation. The impact of SNOs on prices for end-users has not been dramatic. This is because the market as a whole has not been liberalized and with a duopoly, operators tend to shadow each other's pricing structures.

Until recently, Sub-Saharan African regulators and governments have sought to contain the disruptive impact of new technologies on their historic operators rather than encourage technological innovation. VoIP calling has only recently been defined as a legal activity in a small number of countries.[17] Wireless technologies have often remained outlawed or been rendered difficult to use through regulatory inexperience or unwillingness to extend access to low-cost spectrum.[18]

Despite these barriers, in certain African countries these new technologies have gone around regulatory rules like water running downhill. The grey market in international voice traffic using VoIP has varied between 10–30 percent in most African countries, often acting as hidden competition for the historic operator on international voice calling. Before the announced regulatory changes in South Africa in 2004, it was estimated that there were between 70–80 unlicensed wireless-based Internet Service Providers. However the somewhat clandestine nature of these operators restricts their ability to grow their business as an unpredictable environment does not encourage larger-scale investment. This use of new technologies – both legal and clandestine – has helped lower prices for users (particularly VoIP's impact on international prices) and expanded the market, particularly in countries where Wi-Fi is unambiguously legal and operators can use low-cost or free spectrum. However there is still considerable potential for lowering costs and widening usage by actively encouraging low-cost deployment.[19]

Because of fears that change would damage the historic operator, the early steps towards liberalization were highly controlled and still left markets in the hands of a relatively small number of influential, big players. The absence of competition law in most Sub-Saharan African countries means that regulation has legalized a number of de-facto monopolies.[20]

The next steps on the road to liberalization are far less clear than what has gone before. It is almost as if everyone has embarked on a journey without knowing its final destination. Competition has been assumed to be a good thing but policymakers have not always defined what they want from wider competition. In 2004, the first countries in Africa – Kenya, Tanzania and South Africa – announced wider competition frameworks. A number of other countries will announce competition frameworks this year including, Botswana, Nigeria, Uganda, and Zambia. More countries are sure to follow.

With greater liberalization, the responsibility for widening access has shifted. Governments have gone from being directly responsible for universal access to acting as the policymakers and facilitators for it. In practical terms, this has meant working with regulators to set roll-out targets and charging private operators money to raise funds for widening access. What was once a fairly centralized process (involving government and the historic operator) is now becoming one in which many commercial players take different parts of the remit to widen access.

16 Existing SNOs include: Côte d'Ivoire, Ghana (although its effectiveness is hobbled by a dispute with Government over roll-out which is taking several years to resolve), Mali, Nigeria and Uganda. Planned SNOs include: Kenya (now doubtful), Senegal, South Africa and Zimbabwe (also doubtful).

17 Strategies for containing "illegal" VoIP calling have ranged from periodic police raids (Ethiopia) to trying to filter out VoIP calls, often with disastrous consequences for business traffic (Kenya). There are a number of Africa countries where VoIP has been made legal recently (DRC, Kenya, Tanzania, Togo, South Africa) subject only to licensing requirements. In a smaller number of countries (for example, Egypt) it has been made legal for PC to PC phone calls and for Virtual Private Networks (VPNs) because in both instances it would be almost impossible to police effectively. A recent study for ECOWAS and the World Bank (see A1) found that VoIP had been legalized in six out of fifteen ECOWAS countries but this overstates what is actually happening as there are disputes or extremely limiting conditions in four of these countries.

18 See study by Isabel Neto listed in A1. She surveyed 47 out of 54 African countries and territories, covering 95% of its population and found that:" Lack of clarity in regulation and enforcement creates confusion and may discourage smaller players from entering the market. For bigger players interested in taking advantage of economies of scale and implementing common strategies across borders, the heterogeneous regulatory environment will also act as a deterrent and a barrier to entry".

19 The discussion of new, cheaper technology need not be restricted to VoIP and wireless based equipment. It could also include new low-cost network element equipment, including transceivers for optical fiber links, switches, routers and terminals. Much of the complex equipment necessary to build communication networks that formerly could only be purchased from specialist telecoms suppliers can now be bought cheaply from consumer outlets.

20 In Senegal, the historic operator Sonatel controls upwards of 80% of the ISP market and has a similar position in a number of other key markets. The position is very similar in Mauritius.

The new liberalized environment calls for increased commercial risk and decreased political risk.

Several challenges have emerged from this transition. Getting independent regulators in place has taken time and absorbed much attention and energy on the part of governments and operators. Establishment of effective universal access mechanisms has nearly always lagged behind liberalization of the market. Universal Access Funds or Universal Service Agencies are in place in some countries, and additional funding has come from organizations such as the World Bank. However, in Sub-Saharan Africa, the money raised is inadequate for the scale of the task involved. In addition, there are long-term issues of revenue support: there is no developed business model that allows for the steady spread of communications to poorer, rural areas in a financially sustainable way.[21]

Governments and donors have attempted to overcome the economic difficulties faced by poor potential users by offering funded telecenters with a mixture of voice and Internet services, thus lowering the price for users by spreading over many users. And undoubtedly there have been some successful telecenters but overall the results have been mixed. Users seem to be more interested in having a mobile on which they can be reached (either their own or a shared phone.) Connectivity has also often been relatively expensive and not always reliable. In most cases, income from users has not covered operating costs.

The underlying issue is that there is currently no business model for delivering voice and data at an appropriate price to those at the bottom of the income pyramid. Nevertheless, there are examples in the United States, Asia and, Latin America that point the way, using newer, cheaper technologies in combination with existing infrastructure. The lower the entry and operating cost, the better the business case and the higher the likely level of usage.

The situation is particularly acute for Sub-Saharan Africa. It finds itself trapped in a set of "chicken-and-egg" problems that are also mirrored in some other developing countries. The absence of cheap international bandwidth means that even its most competitive economies find it hard to compete at a global level. For example, the cost of offering call center services in South Africa was found to be a third higher than in India, largely because of telecommunications costs.[22] This lack of competitive advantage makes it hard to attract local and international investment. A cost-effective communications infrastructure is almost a precondition for attracting external investment that goes beyond traditional extractive industries. Without investment, markets stay small and uncompetitive.

Much of the national and international infrastructure that created the low bandwidth prices in Europe was built during a market upswing. A great deal of that private investment (particularly on the North Atlantic routes) has simply been written off at 5–10 percent of its original value. The creation of plentiful, relatively cheap bandwidth through this "market accident" has opened up considerable new economic opportunities for the developed world. It has driven local roll-out, whether or not this was profitable in the short-term.

Such an approach is simply not an option for Sub-Saharan Africa and many of the other developing regions of the world. Where major infrastructure has been built, it has tended to be through structures that createdis international monopolies that have kept the price of bandwidth high. The African historic operators that belong to the SAT-3/SAFE club consortium have monopoly access to that capacity, the only significant fiber optic cable connecting Sub-Saharan Africa to the rest of the world.[23] Each company involved invested a certain amount of money and got monopoly access to the bandwidth from that country. Since its construction largely predated liberalization, it is inevitably a club of existing historical operators whose approach to pricing varies considerably. Neither the equity in the SAT3 Consortium nor its bandwidth is easily tradable.

21 This can be contrasted with Latin America where several countries have held reverse auction processes and in Peru, the regulator has approved the setting up of a low-cost, rural operator.
22 See Deloitte study cited in A1.
23 The SAT3/SAFE cable that links 11 Sub-Saharan African countries with Europe and Asia was built using the industry's traditional approach to financing, the Club Consortium model. For background see: http://www.balancingact-africa.com/news/back/balancing-act_247.html

The high cost of underdeveloped infrastructure in Africa

Africa lacks significant regional and international communications backbone infrastructure[25]. As a result, a considerable amount of its voice and data traffic – both within countries and among countries – goes via Europe or North America. For a voice call to go from Nairobi to Kigali it goes via London or for an e-mail to go from Ouagadougou to Bamako it goes via Paris. This situation has its parallel in airline routes where it is both easier and cheaper for a senior executive from a telco in Senegal to fly to a meeting in Kampala via Paris rather than directly. The cost of this international routing of voice and data traffic costs Africa a considerable amount in hard currency payments every year.

Many African countries use relatively expensive international satellite capacity to route calls within their borders and to other African countries because there is no national or regional backbone infrastructure. In the case of one of the poorest countries in Africa, its historic operator spends US$3.2 million on satellite transmission, of which US$2.4 million is spent on routing calls within the country and the balance is spent on international calls.

Africa suffers from a whole range of problems that make the creation of regional and international infrastructure harder. Some are found elsewhere, while others are mainly a continental problem. There are several key countries that are either in or coming out of civil war. There is a high level of vandalism on existing copper cables and other facilities. And there are particular gate-keeping or transit problems associated with small land-locked countries.

Despite these substantial barriers to growth, Africa remains economically the second fastest-growing continent in the world. Although a large part of that growth comes from South Africa, that in itself tells its own story. South African companies are investing in communications across the continent and are an illustration of how the country can provide the impetus for growth across the region.

Unless checked, this kind of dominance by existing large-scale organizations is likely to increase as competition intensifies and is unlikely to bring about lower prices. A number of countries connected to SAT3 have begun to address this issue.[24]

The intractability of policy and regulatory issues in Sub-Saharan Africa indicates that many of those involved are focused on securing tactical victories and for understandable reasons find it difficult to step back and see the way things might be moving. Full competition has almost crept up on the continent and there has been little preparatory discussion about what it might mean. Complete liberalization assumes competition is a "good thing" but much less thought is given to specific policy objectives that might be achieved with greater competition.

However, rather than arguing over the details of what might have been, it is perhaps time to take breath and see whether there's another way of looking at how these obstacles might be overcome. If ICT is a set of tools for development, then what follows examines how it might be possible to gain easier and cheaper access to the technology.

24 The absence of either national or regional competition law makes addressing these issues difficult: there is no equivalent to European Commission competition law. The individual SAT3 country monopolies last until 2007. Nevertheless, in the meantime, Ghana is investigating the possibility of hiving off its SAT3 bandwidth from the historic operator, Ghana Telecom. Nigeria was also going down the same route but policy-makers appear to be less interested since the Nigerian SNO Globacom announced that it would build its own Lagos-London fiber connection. In South Africa, there is discussion about taking the SAT3 capacity away from the historic operator, Telkom. In Mauritius (which is connected to the eastern extension of the SAT3 cable, SAFE) the Government has employed consultants to look at the cost of buying out the monopoly from the historic operator, Mauritius Telecom, which the Government stills owns 60% of the shares.

25 The World Bank has funded two extensive studies that describe the current state of infrastructure in Sub-Saharan Africa: For West Africa, there is the Cross-Border Connectivity Initiative in the ECOWAS region. For the Southern and East Africa, there is the Study of Telecoms Infrastructure and Development Initiatives in Southern and East Africa. For full references, see A1.

2. UNLOCKING WIDER ACCESS TO ICT

The introduction of IP networks as the basis for communications and services is a significant development. IP networks operate in markedly different ways than traditional telephony, and this paradigm shift offers considerable potential for unlocking wider access to ICT. It has already allowed the separation of services and infrastructure and is being built with new, disruptive technologies that lower both business entry and operating costs.

Almost all major telecoms carriers are committed to introducing VoIP[26] services across their networks, and carriers in Sub-Saharan Africa have already begun introducing such services at an international level. A handful of African carriers have announced their intention to make the transition to IP-based networks in the next 2–3 years.[27] But the impact of IP networks has made its presence felt everywhere as operators are increasingly running a hybrid of traditional telephony and IP networks. In the next five years, these will probably cease to be parallel operations.

The introduction of IP-networks has been the midwife of a number of developments across all forms of networks. One of the most significant of these developments – the separation of physical infrastructure and services – is creating new ways of doing business. Since a liberalized environment needs sustainable business models, policymakers and regulators need to "go with the grain" of market developments and understand the implications of these developments.

2.1 IP NETWORKS: A PARADIGM SHIFT THAT OPENS UP POTENTIAL

IP networks are the transmission system for almost anything that can be sent in digital form. Where they are already well established, they have created new markets for services and applications. In the developing world, they allow the growth of decentralized, "intelligent" services at the edge of the network.

Traditional telephony is a highly centralizing technology. The "intelligence" in the network is located centrally (in the functionalities of the switch) and usually controlled by one organization. In its historic form, largely "dumb" devices (telephones) were attached to the network and these had only a limited set of functions. More recently, the functional attributes of devices attached to the network has increased but this functionality is still centrally run.

The telephone network's root and branch structure means that traffic flows to and from exchanges in ways that reinforce this pattern. For example, traffic for international destinations tends to go via a single international gateway. Telecom carriers maintain bilateral relationships with other carriers through the Accounting Rate System (although to a much more limited extent than before).

By contrast, the IP network (the basis for the Internet) is one where no single entity controls anything but the most basic transport and relationships with other networks. The service-providing "intelligence" is deliberately designed out of the network architecture. Indeed, the network is "dumb" and intelligence is at the edge of the network. For example, a computer accessing the network has a far more complex range of service functionality in its application programs and this is not solely related to its size.

Traffic on the network is routed wherever it can find the easiest route and therefore not always via central points. For example, international traffic can as easily flow from an Internet service provider (ISP), a cyber-café or a telephone company: each has only to open a network connection and have the required capacity available. The network design originated from U.S. military demands that it withstand nuclear attack where an important feature was a decentralized network without a central focus or control point. Also from its university origins, it

26 VoIP as a service can and does go over the internet (which is carried on an IP network) but to achieve higher quality calling carriers have installed their own IP networks.

27 Major carriers committed to VoIP include: MCI (100% of all traffic by the end of 2005); AT&T (100% by the end 2010); Telecom Italia (80% of all traffic went by VoIP by the end of 2003). Between a fifth to a quarter of all historic operators in Africa were using VoIP for a part of their international traffic. As these agreements are politically sensitive, establishing exact numbers is difficult. Telkom Kenya is about to offer publicly a VoIP-based international service. Four African carriers – BTC (Botswana), Mundo Startel (Angola), Telecom Namibia and UTL – have announced that they will introduce IP-based networks.

was designed to be open to users through publicly available standards, making it easy to access.

The significance of IP networks and the core argument of Open Access is that they have provided the opportunity to change the structure paradigm. Instead of needing a small number of large, vertically-integrated organizations (as in the telephony model), it is possible (using IP-networks) to have extremely diverse "ecosystems" with a mixture of small, medium, and large organizations.

The decentralized "intelligence" in IP networks has allowed the strong growth of innovative services, content, and applications in the developed world. It is arguable that all of the creative commercial energy that this shift has produced could not have been harnessed through the traditional telephony business model. All of this flows from companies and organizations being able to access infrastructure on fair terms. Therefore, the challenge for those wanting to use competition to foster cheaper communications, technology innovation, and investment in a developing world is to ensure that any "gate-keeping" function (which gives dominant market power to a single entity) is minimized.

For developing countries, this paradigm shift from a closed to open network architecture offers plentiful opportunities to carve out a competitive environment that does not need to follow a single path or necessarily copy all aspects of developed world examples. And a competitive environment shaped by developing countries will open up newer, cheaper ways of getting access to communications that will increasingly enfranchise larger numbers of their citizens.

The basis for these changes can be understood by looking at how those involved describe the operation of IP networks. Diagram 1 on page 4 shows a Network Layers model. Essentially, there are three key layers: physical infrastructure, transmission, and services (including applications and content). In practical terms, 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.[28] In terms of day-to-day reality, these network functions are combined with Reach (the geographic scope of providers) and Type of Customer (wholesale or retail).

A vertically-integrated organization, such as a historic operator or SNO, will sell at every layer: it will carry traffic and offer services. In this way, the historic operator in Africa finds itself selling international transmission to external ISP customers and to its own ISP, leading inevitably to accusations of conflict of interest. An ISP may offer its own infrastructure at a local or city-wide level (using Wi-Fi) to reach its customers but will buy both national and international transmission from another carrier. A relatively recent market entrant in Kenya – KDN – is providing national and international transmission to corporate customers, ISPs, and other carriers but not selling to individual retail customers.

One ISP or cyber-cafe that has an "under-the-counter" agreement with the historic operator in Mali (Sotelma) buys international minutes from the carrier at a wholesale price and sells to its customers at a retail price. Senegal's mobile carrier Sentel (which until recently had a relatively low proportion of its own infrastructure) buys a significant proportion of its national and international transmission from the historic operator Sonatel to provide mobile voice services. A mobile virtual network operator (MVNO) offers a service that goes out over someone else's network for which the operator pays a percentage of its revenues. A short message service (SMS) data service provider will use its own platform to provide text messaged services via the mobile operator's network to the latter's customers. The Layered Networks model describes a world in which there are multiple relationships between providers operating in different layers in the model.

As IP networks begin to take over from telephone networks, this layered approach will become a tool for understanding how markets function. In terms of an Open Access approach, it is being argued that the transmission layer needs to be separated from the other layers in operational terms to create maximum growth through competition in all the other layers. If a vertically integrated entity operates across several layers and dominates any one (particularly transmission or physical infrastructure) it can exert a stranglehold on market growth, particularly if it is a historic operator defending its inherited markets.

28 There are several more detailed ways of describing the layers and these capture what are essentially technical functions of the network. Applications include things like Web and mail browsers. Services include all forms of content whether voice, data or images.

IP networks allow growth at the edges of the network. It becomes possible at the local level to have a small-scale, "plug-and-play" operator interconnecting with much larger operators. Local and municipal networks can co-exist as infrastructure providers alongside more traditional operators. Alternative infrastructure providers such as utility companies and railways can add their fiber capacity to an existing network and sell to those wanting national transmission.[29] More transparent and competitive arrangements can be reached for building inter-country and international infrastructure. The use of IP networks means that newer, cheaper technologies can be used to build and operate services and infrastructure. All of this requires new business models that can reflect the implications of the changes that are already taking place.

2.2 SIGNIFICANT MARKET DEVELOPMENTS – "GOING WITH THE GRAIN"

One of the most significant market developments is the separation of infrastructure and services. The impact of this is already widely known and highly visible in the developed world: the growth of organizations as diverse as e-Bay, Skype, and Amazon.com are a product of a lively market of providers in the service layer. These successful service companies have not by and large been part of the vertically integrated, historic operators.

In Africa, the same process is occurring, but it is not as large or as visible because the service markets take different forms and often services have not yet been legalized because of the perceived need to defend the historic operator. Roughly 10-30 percent of the international voice market in each country in Sub-Saharan Africa is in the grey market. ISPs and cyber-cafes are buying services from international providers to offer calling services. Wholesalers and retailers of mobile prepaid calling cards sell to customers from street corners. In South Africa, larger ISPs operate virtual ISPs (acting as wholesalers) for smaller organizations with local or specialist customer bases. MVNOs will soon start to operate on the continent.

A transition is occurring – both in the developed and developing world – from large vertically integrated organizations (such as the historic operators and SNOs to a small number of infrastructure providers feeding a mass of service-based companies. These changes are messy and not clear-cut but they will lead to more horizontal players with trading between the different network layers in the market. Whether from market imperatives or regulatory pressures, significant numbers of historic operators are separating out their different operations into more or less free-standing subsidiaries.[30]

Currently core infrastructure is usually provided by the historic operator but there have been a significant number of instances where SNOs and alternative infrastructure providers (such as utilities and railways) have set up competing infrastructure links. Even with the falling costs of technology, infrastructure is a large-scale, big-investment business and therefore there are unlikely to be more than one or two large-scale entities providing it in a mature market. Greater infrastructure competition depends on the value of the market and population density found in a particular country.

Reasonably wealthy and densely populated countries such as Nigeria and South Africa have two infrastructure providers. Thinly populated and poorer countries such as Mali or Niger, may only have one. Mid-scale countries such as Kenya have a second infrastructure operator that provides competition in the larger urban markets and between those centers.[31] In either of these cases, licensing alternative infrastructure providers can open up competition on major transmission routes. Covering a thinly dispersed rural population is the ultimate challenge: it may only sustain one infrastructure provider and then only with soft loan financing for capital investment. But even in these circumstances, it would make sense to have some element of competition to allow price and service competition to occur.

29 Three power companies in Africa are actively selling their fiber capacity and have the relevant license in their respective countries: Voltacom (Ghana), Zesco (Zambia) and Powertel (Zimbabwe). The Ghanaian government has announced its intention to privatize Voltacom.

30 Ghana Telecom has been asked by the Ghanaian regulator to separate out its broadband operation after various accusations from competitor ISPs. The new MD of Telkom Kenya has announced that its new ISP will not be subsidized from revenues derived from other parts of the company.

31 Owned by the Sameer Group, KDN is investing US$330 million in creating an East African transmission network. It is building a national network in Kenya between main cities (including the Nairobi-Mombasa route to connect to EASSy, the proposed international fiber cable. It will connect to other networks in neighboring countries and is close to completing a fiber route to the Ugandan border.

Because of cost, the idea of a single, rational infrastructure network seems like a good idea where resources are short. But this beguiling notion is unlikely to work except in highly controlled circumstances where good governance ensures that vested interests are held at bay. This obviously would work better in some countries than in others. Therefore, it is almost certainly better to "overprovide" rather than leave control of the infrastructure resources in the hands of a single entity, whether publicly or privately controlled. That said, within a competitive framework there are a number of mechanisms that allow operators to share resources (and thus gain some cost-savings): some have been self-organized, while others have been imposed by regulatory pressure.[32]

The strategic business shift for historic operators is to move from getting a majority share in every service market to seeing their future as taking a share of revenues on all service markets as they emerge: in other words, to become a carriers' carrier at the transmission level. A few historic operators in Africa have already been making plans in this direction.[33] Following this strategy may start with simply separating out different parts of the business and ending internal cross-subsidies.[34] The business case for acting as a carriers' carrier involves creating infrastructure companies with lower levels of staffing and costs and seeking to persuade a significant part of the market to use the company's services. Volume and increased efficiency through technology innovation has to compensate for low margins.

If an infrastructure provider offers services, it ends up competing with its own customers. This difficulty can already be seen in the most liberalized markets, in relation to the historic operator's relationship with mobile operators and ISPs. It sets up a constantly defensive dynamic in the discussion between the historic operators and other players. It enables neither side in the discussion to focus clearly on innovation and development of the market.

The second significant market development is the availability of a number of "disruptive technologies" that are offering the possibility of cheaper access to voice and data than traditional wireline. Some examples include VoIP, Wi-Fi, Wi-MAX, code-division multiple access (CDMA), enhanced data GSM environment (EDGE), and very small aperture terminal (VSAT). VoIP network deployment costs often come in increments of US$50,000–$100,000, rather than the US$1 million plus increments of telecoms switching facilities and dedicated circuits. As a result, it is possible to add capacity in smaller steps that will begin to make return more quickly rather than the multi-million traditional telecom equipment investments that require many years before they fill up and make a return over much longer periods. Smaller investments can often be financed out of cash flow rather than requiring major external borrowing.

Disruptive technologies changing the shape of the market

Disruptive technology is a term coined by Harvard Business School Professor Clayton M. Christensen to describe a new technology that unexpectedly displaces an established technology[35]. These technologies operate at the edge of the possible and may have performance problems because they are new. Although it is difficult to remember, the phone was once one of these technologies.

Larger companies work with existing technologies that are proven and seek to refine and develop their use. Disruptive technologies often undercut the business model of larger companies by demanding structural changes and thus are particularly hard for them to react to: why offer a service more cheaply when you make good money from a more expensive service? In the telecoms field, equipment investment cycles (the economic life of the equipment) for core equipment have been as long as 10–15 years and previously even longer. The newer disruptive communications technologies have buying cycles that are much more like those for PCs, typically requiring updating over 2–3 year cycles.

Depending on the structure of national and international trunk traffic tariffs, sending calls by a data network may also result in significant savings. With these savings, a developing country telephone company can consider connecting a range of places that with traditional public switched telephone network

32 Self-organized initiatives include things like MVNOs using existing networks and national ISP associations agreeing to create IXPs. Imposed infrastructure cost savings would cover things like shared use of masts (often on environmental grounds) and of network (for areas of marginal business).
33 TTCL has announced its intention to become a "carriers' carrier" with the idea that it will be given the fiber assets of the Tanzanian power and railway prostates. In another instance, TDM in Mozambique, whilst it will not become a carriers' carrier, is clearly thinking about how it will build its business model with infrastructure as a key element.
34 See endnote 29 above.
35 See his book The Innovator's Dilemma.

(PSTN) investment might simply not have been viable. A similar set of arguments apply to using wireless for national traffic links. Historic operators in Africa that have used wireless links between towns indicate that they have cost between 10–15 percent of the sum needed for laying equivalent fixed-line connections.[36]

These technological changes might be implemented as they stand without significant policy or regulatory change. But just as IP networks allowed the "Siamese twins" of infrastructure and services to be separated, these disruptive technologies hold a wider potential to allow the creation of small and medium enterprises (SMEs) to address low-income markets. This is already happening, but against a largely unsympathetic policy and regulatory environment: the changing of this environment (particularly allowing access to free or low-cost wireless spectrum) will allow the market potential of disruptive technologies to deliver a wider range of new benefits.

2.3 THE OPEN ACCESS APPROACH

Open Access is a broad approach to policy and regulatory issues that starts from the question: what do we want to bring about outside of purely industry sector concerns? It places an emphasis on: empowering citizens; encouraging local innovation, economic growth, and investment; and getting the best from public and private sector contributions. It is not simply about making micro-adjustments to the technical rules of the policy and regulatory framework but seeking to produce fundamental changes in the outcomes that can be delivered through it.

Micro-managing competition with detailed rules is too slow and cumbersome: developing countries are not alone in finding difficulty in reaching decisions in this way. In future, regulators and policymakers will need to work with an approach that involves a lighter set of rules and base these on a stable set of core values that encourage technological innovation and growth.

The Open Access approach is about creating a set of core values that can be summarized as follows:

- a technology-neutral framework (that encourages innovative, low-cost delivery to users),
- competition at all layers in the IP network (allowing a wide variety of physical networks and applications to interact in an open architecture),
- transparency to ensure fair trading within and between layers (that allows clear, comparative information on market prices and services),
- the circumstances where everyone can connect to everyone else at the layer interface (so that any size organization can enter the market and no one takes a position of dominant market power), and
- devolved local solutions rather than centralized ones (encouraging services that are closer to the user).

The "openness" creates a market dynamic at every level in the system, emphasizing the need to innovate in cost terms to expand the user base at a price and in a form appropriate to them. A diversity of services and physical infrastructure means that no single business model has to fit all users: smaller, lower cost operators can go where larger organizations might fear to tread.

Through Open Access, the market (with a gentle hand from the public sector) can begin to turn communication into a public good available to wider groups of people. Naturally, the private sector needs to obtain short-term returns for its shareholders. Therefore, the public sector has to create a wider range of circumstances in which this can occur: it needs to provide incentives for the private sector to grow the market. The public sector for its part will continue to represent the public good, and in this role take medium and long-term risks that the private sector might be unwilling to shoulder. For example, it might act as the equivalent of an "anchor customer" for the roll-out of a network or invest in the network itself under some circumstances.

Although Open Access places the effective operation of markets at its core, it acknowledges that the market will not deliver in all circumstances. It sees the challenge as being able to extend communications to those at the bottom of the income pyramid by lowering the cost of services. In these situations

36 Although precise details are commercially confidential, we are aware of two relatively large-scale projects to deploy Wi-Fi relay links: one to connect two countries whose capitals are relatively close to each other and the other to build a national backbone for a smaller country. The capital costs of these projects are significantly cheaper than their wireline equivalent. The estimate of the cost-saving through using a Wi-Fi relay link was provided confidentially by a senior manager at a Southern African historic operator in early 2005. At the local loop level, both Wi-Fi and Wi-Max can provide extremely competitive capital development costs. There are developed, city-wide canopy solutions in Accra, Dar es Salaam and Nairobi. There are three Wi-Max solutions – in DRC, Kenya and Malawi – all again being used to deliver at the local level in cities.

the function of the public sector is to create the circumstances for successful Open Access (through partly funding infrastructure and thus assuring its availability to all) and to create incentives for the roll-out of services as widely as possible.

Open Access seeks to ensure that market gap (or "market-stretch") funding will deliver final market demand. In particular, the public sector's role in Open Access is to address key structural problems such as national and international infrastructure. It needs to play a role in unlocking the "chicken and egg" problem that if there is no market, there is no investment but that without investment, the market will not have the opportunity to grow. But even if this is successful, there will continue to be areas of social need that the market will not meet and these remain the responsibility of government.

In this way, the Open Access approach seeks to create a "virtuous circle" that addresses almost all main impediments to growth. The "bottom-up" operators of infrastructure at the local level will increase the user base. This will feed into the volume of traffic at the regional, national, and international levels.

Service operators at every level will have some level of infrastructure they operate themselves. As they expand, the reach of the infrastructure network and its capacity will grow along with them.

At each level, roles vary. A national infrastructure provider wholesales (or connects) to those at a local level. But the same national infrastructure provider connects to retailers of international bandwidth that is supplied wholesale to it (or its customers) at the international level. The separation of infrastructure and services (or wholesale and retail) allows the emergence of clearer roles for each of the players. Organizations no longer need to compete with their own customers and the costs of infrastructure become more transparent.

Open Access focuses on lowering the cost of business entry but is "technology-neutral." The Open Access approach seeks to emphasize innovation that makes providers look for whatever technology works at the right (lower) price: the technologies that are suitable will vary enormously depending on historic legacy equipment and physical circumstances.

Creating trust between service and infrastructure providers

One of the major issues in an Open Access business model is that it requires trust in parties outside of one's own organization.[37] *A service provider potentially puts the whole business at risk through trusting somebody to supply the required infrastructure. The service provider needs to be assured that the infrastructure provider is going to tackle its needs with the same degree of attention as if the organization was doing it itself. The fundamental factors for assessing this are no different from any other area of business. They include: financial stability; operational capability; gradual development of the offer; and a reasonable price. The two keystone business practices for establishing trust therefore are non-discriminatory pricing and no competition from the infrastructure supplier itself.*

Trust is also easier to establish if there is a feeling of mutual inter-dependency. This is why alternative infrastructure providers can succeed: they are focused, know who they depend on, and are eager to be cost effective as they need to acquire new customers. And the service providers also know this. Mutual self-interest means that each side needs the other to succeed.

The historic operators as vertical players have very reluctantly (pressed by legislation) made some network resources available to others. This is of course not a good foundation for creating the necessary trust. There are all too many stories of the tricks and delaying tactics employed. The infrastructure provider sees the other party as a competitor and not a valued customer.

When the combined market share of all non-facilities-based service providers approaches the historic operator in size, the network department (which provides the infrastructure) of that operation will begin to behave differently. It will begin to see its volumes are shrinking, and it may be faced with staff lay-offs. At this point, there is usually a shift in "mind-set" and it begins to behave properly to both its internal and external customers.

Where there is only one infrastructure provider, two things are essential to creating trust. First, there is a need to separate out the service provider elements of the historic operator. Regulators in several developing countries have already requested this for both mobile operations and ISPs so that they operate at "arms-length" to network provision. In the medium-term, a complete separation would almost certainly be feasible. Secondly, it would be important to create governance structures with oversight powers of the kind described in the sections below.

In contractual terms, there is a variety of Service Level Agreements (SLAs) that have been developed out of fiber lease, and capacity sales deals between service providers and infrastructure companies. These address all the detailed conditions and actions between the two parties should anything happen. Once trust is established, these are rarely called upon.

37 This trust has grown in a wide variety of business sectors in the developed world where outsourcing of functions (both nationally and internationally) has been an accepted approach to lowering costs. In Sub-Saharan Africa, the pressures on enterprise costs have until recently been less intense: the relative lack of competition in the airline or banking sectors in many countries is a good example. However this relative lack of familiarity with outsourced relationships and the trust required to operate them will change for two reasons. Increasingly a small but significant number of African countries are acting as outsourcing markets for developing countries and there is steadily increasing competition across the continent in market sectors outside of communications. For example, Zantel is using Vodacom's mobile infrastructure to roll-out its mobile service on the Tanzanian mainland (source: Tanzania's Guardian 1/7/2005)

2.4 RURAL "PLUG AND PLAY"

At the rural level, Open Access emphasizes the importance of small-scale providers who can provide cheaper services than traditional operators because their entry and operating costs are lower. In an Open Access environment, these "plug-and-play" operators have the potential to spread voice and Internet use to places currently not covered, while at the same time encouraging significant economic activity in rural areas.

At present, a single base station connected to the network might cost between US$125,000–$250,000 to deliver. Recent approaches by one manufacturer may potentially reduce this cost to US$100,000.[38] Work carried out for this study suggests that it may be possible to lower this further to around US$30–50,000.[39] Operating costs would be kept to a minimum by offering almost exclusively prepay options to users and the operation would be simplified to allow non-technical users to run it. While this desire to lower business costs might equally happen without an Open Access approach, there is not (in developing countries) a policy framework that provides incentives for this to happen and allows its practical operation.

The local "plug-and-play" operator would have an interconnection agreement with the traditional operators (mobile or PSTN) for calls that were routed out into the wider network and equally, back into the smaller, local network.[40] Each would derive income and advantage from this arrangement. The large-scale mobile operator would not have to re-engineer its business model to chase marginal markets but would gain access to additional traffic. The small-scale operator would gain income and derive strength from being part of a wider network.

Providing electricity to power the network becomes a major design factor. It would be essential to link the encouragement of communications and power supply. If the power utility is rolling out new power lines, the addition of a few extra strands of fiber is a marginal additional cost.[41] A local power operator would be able to sell power to a local store, school, clinic and Internet café as well as provide telecommunications.

Reaching users at the bottom of the pyramid

C.K.Prahalad and Stuart Hart defined the different populations of the world in terms of income.[42] They identified that 4 billion people or more live on annual incomes of less than US$1500. In other words, somewhere between US$2–$4 per day. Michael Best has calculated that communications micro-businesses in India can sustain themselves on US$3-$5 per day.[43] These may or may not turn out to be the correct break-even point but the point is eloquently illustrated. For even double or triple that sum would fundamentally change the parameters of the current business model.

To reach this group of people, Prahalad identifies a number of factors for success based upon existing companies (from small local companies to multinationals) that already operate well in these markets. All are interesting but a few are absolutely key for communications activities. Because the skills needed are not widely available, it is important to simplify the activity. It should not require sophisticated technicians to implement or maintain. Interfaces need to be simple and easy to learn. Business practices may often make use of hybrid approaches: in this case, it may involve blending existing mobile network operations with small-scale Internet functionality. Simplicity of operation should mean lower manufacturing costs because the functionality needed in other markets may not be relevant here. Indeed different functionalities may become more relevant.

This approach needs to be accompanied by a policy that provides as fewer barriers to entry as possible.[44] Government needs to foster local SMEs in the sector, including financing. From the regulatory point of view, licensing should be as cheap as possible (either at no-cost or a nominal charge) and might even make extensive use of license-exempt radio bands.[45]

38 Whilst every operator and equipment manufacturer is looking for ways to lower costs, they do so from very different positions. Mobile operators are relatively large organizations and therefore their breakeven position will be higher than their smaller counterparts. Likewise traditional, developed world equipment manufacturers are large-scale entities and look for ways of gently migrating their customers downwards in terms of lower equipment costs: their business model would have difficulty sustaining price cost drops of over 50%. Developing world equipment manufacturers (like Huawei of China and Omniacom of Tunisia) have no such inhibitions and offer cheaper options to the larger telephony organizations. However below this level there are also the small-scale companies than are building local and national solutions with IP network equipment that can be bought out of an online catalogue at much lower costs: they do not need to buy "total solutions" as functionality can be increased as markets grow.

39 A discussion with an operator that is installing a CDMA-based network during the redrafting of this paper suggests that it is already possible to achieve the US$50,000 figure already.

40 This is the basis of the operation of the small-scale, rural telecommunications operators in the USA, many of whom are members of the National Telecommunications Co-operative Association.

41 There are a number of different kinds of synergies that can be found when combining deployment of electrical power distribution networks and optical fiber networks, whether underground or overhead (opgw or skywrap). The operation of the power network requires communication for control and measurements and the fiber infrastructure will facilitate new ICT applications and broadband services attracting more customers and requiring equipment consuming power that will add to the sustainability of the power network.

42 C.K.Prahalad and Stuart Hart, The Fortune at the Bottom of the Pyramid, Strategy + Business, Issue 26, 2002

43 The Wireless Revolution and Universal Access, Trends in Telecommunication Reform 2003, Michael L Best for the International Telecommunication Union, 2003

44 Whilst it would be tempting to introduce asymmetric charging to address the imbalance between rural and urban calling, it would introduce a somewhat cumbersome level of price control that would be at odds with the wider thrust of reducing micro-management of the sector.

45 See Isabel Neto study cited in A1.

These rural operators might emphasize voice provision first but at the same time each might provide one or more access points for the Internet. The voice offers made by these operators would be aimed at satisfying three different kinds of market need: conversations with family and friends, locally and nationally; making local commerce and social delivery more effective; and allowing those in these areas to be contacted by friends and relatives in the Diaspora.

The operators of these organizations would reflect the culture of the region in which they were located. In some parts of the world, there is a strong entrepreneurial tradition to draw upon. In others, there will be established forms of social enterprise like cooperatives that can take on the task. Often it will be the women of the community who will be empowered through doing this activity, providing new income for their families and communities. Although less visible than telecenters, there is a considerable amount of experience of this kind of provision already at a local level.

In broad terms, there are three different approaches to creating voice and data services at this level: a franchise model (similar to Grameen);[46] a hybrid approach that combines existing mobile technology with IP voice and data; or a completely distributed model that depends on raw IP connectivity.

The franchise model starts with the pragmatic assumption that access to voice is the service of most immediate interest to potential users but it can be combined with a central point for access to the Internet. A number of places in India have this kind of provision.

The franchise model relies on encouraging existing mobile operators to roll out a coverage "footprint" to cover an ever-wider range of users. They also need to provide a simple franchise model that works well with relatively unskilled, rural people. In effect, the local operators – the franchisees – are selling handsets and call–time.

The next model is a hybrid mobile-IP connectivity option. The local operator can offer Internet connectivity to a small number of government and private sector clients. Users' calls can go locally as VoIP traffic, while long distance calls can be converted to enter other networks. This option might be particularly suitable for small towns where there is sufficient population to create a user base in the high hundreds or low thousands.

Longer-term, it makes sense to build a model that is completely based upon traffic going over IP networks.[47] The system would support local VoIP calls over systems such as Wi-Fi and connect over an IP access base station to deliver them. It might be able to extend 20–50 kilometers from networks run by existing operators. Despite some drawbacks, this option has significant cost advantages worth considering.

2.5 INFRASTRUCTURE PROVIDERS AND MUNICIPAL NETWORKS

At the national and city levels, Open Access emphasizes the importance of building networks that can help provide cheaper, lower-cost access to all users, particularly to government facilities such as schools and hospitals, and user-access points in poor, peri-urban areas. However, the networks are built and whoever operates them, the aim would be to connect an ever-widening base of users to the national infrastructure at prices that can become sustainable for all.

The key change would be for the historic operator to undergo a process of transformation that would allow it to emerge as the infrastructure provider. Depending on the history of the historic provider, this would be more or less difficult. The process will be relatively straightforward for historic providers that remain government-owned and set up operationally separate "business units" that are profit centers. But it will be more difficult for historic operators that still merge operations and cross-subsidize parts. If the historic operator has already been sold off in part or in whole, this may mean that the issue will have to be tackled in policy and regulatory terms.

46 The term franchise is used in its commercial sense: the seller operates as branded agent who receives financing and support from the parent operator.
47 Such a model is already being tested in one African country where the operator will offer IP payphones because it does not have a mobile license. The details are commercially confidential.

Within this overall change, there would be a number of different options: a single, trusted nationwide infrastructure provider at all levels; trusted infrastructure providers at two different levels (national and district/municipal); and the encouragement of two competing infrastructure providers in every area, the alternative infrastructure provider using the assets of the utilities and railway organizations. The choice between these options is largely a function of scale but also might include considerations of governance.

Existing mobile operators might choose to develop their own trunk networks or simply use those provided by the new infrastructure provider.[48] Also, if there are more than two mobile operators, there would be good case for network sharing with new entrants under agreed terms as the market matures. This might lead to new entrants focusing more on under-serviced areas or the addition of MVNO competitors competing for new customers in a price band not currently offered. In this way it would be possible to share costs without losing overall business potential and in either case, there would be a higher level of competition on price, added services, and packages.

Infrastructure and services would over time be largely separated. In this circumstance, a country might have anything from 30 to several hundred service providers. These would provide the following kinds of services: voice (mobile and fixed), data, Internet and content and consumer services. In each service area, competition would best be maximized by the existence of 4–5 companies.[49] The strong growth of national providers wholesaling services would in turn feed into the further growth of privately run cybercafes and phone shops. The offerings made by these service providers would be aimed at every level of the millions of people currently using mobile voice.

The structural creation of an infrastructure provider will not by itself lead to an effective market dynamic. There are historic trust issues that need to be dealt with. Service providers need to know that they will get equal, non-discriminatory access to the infrastructure, and the infrastructure operator must have this cardinal principle put into its founding constitution.

In addition, the governance structure for these types of entities needs to include the key stakeholders at the board level: business users, consumers, and government. The board of the new entity would emphasize lowering the costs of using the infrastructure but also have to ensure that it charges enough to maintain, replace and renew its infrastructure. On this basis, the new entity would not be able to function effectively if it inherited all or most of the staff of the historic operator. If there was interest, it would be possible to take into the structure a private operator who would also invest in the infrastructure. Return would be based on scale of shareholding relative to investment and other contributions to service and efficiency.

At a city level, municipal networks may offer a useful addition to infrastructure development. These may be appropriate in the two to three largest cities in the larger country markets, but will very much need to be driven by local political and private sector champions. Jigawa State in Nigeria has already put in place a satellite network for the state government[50] and others in a public-private partnership, and Kano has similar plans. In South Africa, both Tshwane and Johannesburg have plans to develop networks as and when it becomes a legal possibility. At least one other smaller municipality is considering setting up a Wi-Fi network.

Although the subject of fierce policy discussions, municipal networks exist in a number of countries (France, Finland, Germany, Netherlands, Sweden, and the United States) and in certain circumstances have been quite effective in promoting the developing of city or municipality-wide infrastructure growth (see Appendix A5). Countries with several dense urban population centers will lend themselves to the development of advanced municipal networks at a city level. However, the urban sprawl and large rural areas of the United States (where wireless is often used as a strong complement to fibre) may provide a better guide to successful approaches, for say the rural areas of Africa, than the more densely populated city conurbations of Europe, Hong Kong, and Korea.

48 Existing mobile operators might be encouraged to build infrastructure capable of meeting wider needs through offering them tax concessions.
49 Three companies or less can shadow each other's pricing or form uncompetitive price groupings. 4–5 players offers the possibility of a greater degree of price and service competition.
50 Operated under a domestic data license.

2.6 KEEPING TRAFFIC LOCAL AND REGIONAL TO SAVE MONEY – NATIONAL AND REGIONAL INTERNET EXCHANGE POINTS (IXPs) AND INTER-COUNTRY LINKS

The Open Access approach emphasizes the importance of effective traffic exchange at national and regional levels to save money (in order to give cheaper access to users) and to encourage local service developments in the applications and content layers.

The local traffic flowing through national IXPs as a proportion of overall traffic varies from country to country. In broad terms, the more developed a country's economy, the cheaper and more available the connectivity, the greater the proportion of traffic that will remain at a local level. For example, most estimates of local traffic in South Africa going via the Johannesburg exchange (JINX) are around 50 percent of total traffic. Whereas in Kenya, the proportion of local traffic is between 25–30 percent. But by contrast, just 10 percent of Internet traffic generated in Latin America has a destination in another country within the region. In a competitive environment, exchanging traffic at local level should be cheaper than doing it internationally and therefore, it is not hard to see that substantial cost-savings can be made with national IXPs.

But IXPs also reduce the time needed to send and receive data. With better access speeds, a range of new economic opportunities open up at the local level, including web browsing, streaming and e-commerce. There is likely to be a steady increase in the number of local domain names and more importantly, locally hosted sites. New services like video-conferencing, telemedicine and e-learning become possible.

The idea of keeping regional traffic within the continent will only be a practical reality if the price of doing so is cheaper than sending it internationally to achieve the same result. This has to be the fundamental business case for achieving this objective whatever other political considerations may apply.

For this to occur, there must be a number of competitive regional carriers whose role is both to exchange traffic between countries and to aggregate international traffic that can then be peered with their equivalents on other continents. Regional licensing templates under discussion in various parts of the world provide one approach to this task. Likewise, there is nothing to stop governments and their regulators offering simple and cheap licenses to build bilateral links between countries if the services offered are on Open Access principles. These licenses can then be bid for by whoever has the money and expertise to build and run them. A tender process of this kind would include the historic operators but would also be open to anyone else with the right expertise and finance.

Historic operators from two different countries might come together to bid. Alternatively a historic operator might work with a private partner. Or the route might simply go to a wholly private partner. Governments would stimulate the roll-out of the routes they considered a priority and these would then be "filled in" by creating a series of bilateral or sub-regional licenses by simply announcing a desire to see the routes built.

2.7 BRINGING DOWN THE PRICE OF INTERNATIONAL CONNECTIVITY

The Open Access approach emphasizes the importance of bringing the cost of international bandwidth down to cut the cost of communicating for developing countries (particularly Sub-Saharan Africa), help spread national infrastructure, and to encourage the growth of new global businesses such as call centers and outsourcing.

The overall aim would be to provide more competitive rates for international bandwidth: for example, donors in Africa might set as an objective the desire to lower international rates by one-fifth to one-tenth. On the terrestrial stretches it would be possible to reserve a certain number of fibers for national use, thus pushing out the reach of individual countries' national infrastructure.

There is currently not enough private sector interest in building international infrastructure. On the supply

side, there has to be an increase in the amount of traffic brought about by lowering prices. On the demand side, there have to be improvements in national infrastructure that will connect users more effectively at regional and international levels. To break out of the "chicken-and-egg" situation described in section one, there may need to be an injection of public (donor) funds to create an international infrastructure that will bring prices down to European levels. This will encourage what is already happening elsewhere: high-volume, low-margin traffic growth rather than the reverse.

The traditional route for financing international fiber cables – club consortia – do not have either tradable shares or bandwidth. Because they operate at an international level, it is much harder to develop rules of trade that operate elsewhere. For instance, in Africa there is no equivalent to the European Commission to deal with international entities. Competition law at a national level is currently only a viable recourse in a limited number of countries, including Namibia, South Africa, and Zambia.[51]

The challenge is to create structures that maximize private investment, while acknowledging risk and that allow open access to all on a fair and equal basis. How infrastructure is delivered will vary according to the traffic and circumstances of different continents. For example, while fiber in Africa is undoubtedly a cheaper method of delivering high-volume traffic, satellite and microwave will continue to play a significant role in reaching geographically distributed populations.

For international infrastructure, there are three broad options: a special purpose company (for projects not yet developed); a hybrid company (for projects already seeking finance); and more ambitious, continent-wide entity to bring together disparate infrastructure projects. Each addresses different requirements and can be nuanced in a number of ways.

For projects that have yet to start, the special purpose company would make it possible to follow the precedents set by the oil and gas industries when building pipelines. A special purpose company

Africa: The challenge of financing international bandwidth

Because there is significant bandwidth demand both with in Africa and internationally[52], there are now a number of major infrastructure projects designed to meet this growth. These include an African satellite consortium called RASCOM and a number of different fiber projects to connect East and Central Africa including EASSy, Comtel[53] and Com-7. With the exception of COM-7 which involves regional power companies, these projects are almost entirely supported by the historic operators.

But this time there is a key difference to how SAT3 was financed. Many of the incumbent telephone companies participating in EASSy[54] and Comtel may require direct donor funding so they can meet their financial contribution to the project. If external donor funding supports a closed Club Consortium structure, it will be financing infrastructure in a way that does not necessarily accelerate the lowering of bandwidth costs or encourage the growth of new opportunities.

Most of the projects identified will require some element of donor funding if they are to be implemented. However the total cost of all the projects may well exceed the resources the donor community can make available. Most of the historic operators requiring money to get involved in infrastructure have not been privatized. Because of their financial situation and a lack of adherence to international accounting standards, they are not an attractive proposition for commercial finance. By contrast, publicly traded historic operators such as Sonatel and Telkom South Africa have been successful in raising project capital. Even if one or more gets commercial investment, the financing issue will remain for the creation of the backhaul links between different countries.

As a result, private finance opportunities are available but are not maximized. This is particularly true of soft-loan finance and local stock exchanges. There have been a number of market placings and the sums raised have been substantial. Furthermore, potential alternative infrastructure providers such as power and railway companies have in most instances been excluded from seriously participating in this process of developing new infrastructure at both regional and international levels.

A number of these projects have substantial areas of overlap. To address this problem, the New Partnership for Africa's Development's (NEPAD's) e-Africa Commission called a meeting in July 2004. Out of this and subsequent smaller meetings came a network map that NEPAD feels represents the network that it would like to see built. This network seeks to create at least two connections for each country in Sub-Saharan Africa to other countries but also a similar choice for connecting the continent to the rest of the world. This level of choice is essential for all operators in the region. It is also adopting the same approach in West Africa. A meeting will be held in July 2005 to try and agree to a network map.

51 Botwana has plans to introduce competition legislation
52 See Forecasts cited in A1.
53 Comtel looks less likely as in mid 2005 Ericsson decided not to be one of the main private sector investors. http://www.balancingact-africa.com/news/back/balancing-act_262.html
54 At the time this paper was completed, early indications were that EASSy would get its financing completely from private sources. They have been able to achieve this through the involvement of a number of private sector companies.

would be created that might issue shares but could also receive debt securities. The main purpose of the special purpose company would not be for it to make a profit but to facilitate profits to be made elsewhere by the participating companies. As with the club consortia, there should be a managing agent and as with that structure there is a potential of a conflict of interest: within reason, the partner investors want to keep managing agent fees as low as possible whereas the managing agent wants to increase them. This would be covered by a transparent payment and a contract that would be performance-related and have an incentive framework that maximized both traffic and income.

The contributors would enter into a multi-party contract that defined the following:

- Contributions from the participating investors.
- A pricing framework designed to cover costs, and a reasonable return (as defined in the contract but in the light of the fact that the company is not designed to be a profit-generator).
- Access to the capacity by others on non-discriminatory terms, taking initial investment and risk into account.

For existing projects, a hybrid company might be set up. Those able to raise a proportion of a fiber project privately would create an entity that would have two owners: the commercial investors and the donor investment. The latter company would invest in an international fiber project on the basis that its fiber capacity was open to all and that its capacity would be offered at successively lower prices for a period of time to encourage downward price movement in prices.

The hybrid company would offer to finance the portion of the project that cannot get funding through the market. To make the period in which the prices were held down more acceptable to those funding their investment through the market, the Open Fiber Access company might take a larger percentage of the overall risk (possibly 75–80 percent of the overall risk). In effect, a hybrid financing solution would be created in which those capable of finding market funding could set up a club consortium that would invest alongside the donor funded company.

The final option would be to set up an overall holding company that would act as the custodian for all the infrastructure projects. In this way, all the disparate infrastructure projects could be used, if not brought together into a single network. The purpose of such a structure would be to overcome the kinds of licensing and charging difficulties that terrestrial projects (like Comtel in Africa) have encountered.

The key stakeholders for Board representation for each of these different options would be a mix of the following (depending on particular circumstances): service operators, infrastructure operators, mobile phone companies, and large corporate customers like banks and multinationals.

2.8 IMPLICATIONS FOR POLICYMAKERS AND REGULATORS

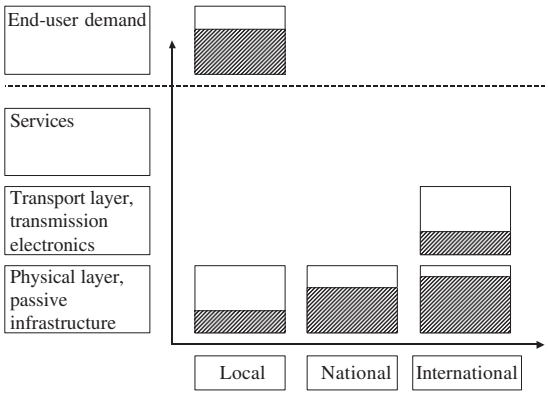
The approach suggested above has the following implications for policymakers and regulators:

- There has been an understandable need to respond to issues raised by consumers and industry, often focusing solely around issues of price. With any new approach it will be important to identify what the bottlenecks and restrictions are within the sector itself: what is preventing the development of the market? Who is withholding access for new players? Each of these bottlenecks can be addressed through either competition or regulatory mechanisms. Where competition legislation does not exist, it is important to put it in place to address issues of significant market power that existing regulatory frameworks may not be able to deal with.
- Current regulation is created around a number of structural frameworks that are often technologically defined. The three-layer IP network definition – the physical infrastructure, transmission, and services – offers a new framework. It allows regulators to make a clear assessment of who holds market power in a world of converging technologies and will reflect the underlying reality of the new IP network paradigm.
- There must be a successful separation of services and infrastructure to create greater clarity about market pricing and access to infrastructure. The principle of open access to infrastructure for all

players is a central part of this change. Regulators need to ensure that larger entities operate services and infrastructure at "arms-length" from each to ensure equity and transparency in the market.

- Policymakers and regulators as the referees of different interests have a key role to play in creating trust in the marketplace. In practical terms, the Open Access approach suggested frequently needs the setting up of bodies that represent both the public interest and the industry. It is important to ensure that these kinds of bodies contain a wide range of qualified representatives at board level, particularly the newer parts of the industry (the ISPs) and consumers. Policymakers and regulators must deal fairly with the tensions created by the existence of dominant players in the market.

DIAGRAM 2: Place for donor support in different layers and areas



The potential of Open Access in Sub-Saharan Africa

An Open Access approach has the potential to allow:

- *Governments to focus on infrastructure needs in ways that do not simply entrench the historic operator or other dominant players. A few countries have already realized it is possible to bring together a range of state assets (including those outside of the historic operator) in the service of this task. Open Access suggests ways of creating new models through which this might occur.*
- *Faster market development through the creation of higher levels of trust and cooperation among competing players. In particular, it seeks to end the sterile arguments about what the historic operator should or should not do and its capacity to put a brake on speedier development of the market.*
- *Strong local champions to play a role in infrastructure development at the city and district level, in ways that will encourage local African governments to think about what makes its different cities and towns competitive in a modern information era.*
- *An emphasis on business models that will address low-income users in rural areas. It will bring together existing entrepreneurial energy, new local investment and the creation of employment where countries need it most, in the rural areas.*
- *A means of maximizing public and private finance in infrastructure without public involvement forcing out much-needed commercial financing. It offers new models for investment in infrastructure, particularly in international infrastructure. In this way, it will create cheap, widely available bandwidth to deliver on a wide range of development objectives.*

Donors will probably contribute most by lowering the structural thresholds for local and national provider of services, not by involving themselves in large numbers of local players. Local players have the least expertise and influence in infrastructure issues, where sharing of facilities is most needed. Any donor support of infrastructure, in particular for the large international projects (but also for cross-border and other national backbones) must be conditional on Open Access principles, with non-discriminatory access for anyone in different layers.

Donors should refrain from supporting any market activity at the service level since this would just distort the development of markets. If infrastructure is made available cheaply, donors should support end-users and local demand. Equally, they must abandon the idea of supporting any separate, dedicated networks being set up for "anchor" customers like schools, health care facilities, and government administration departments. This just undermines the future functioning of the market in the higher levels of the network model.

3. TAKING ADVANTAGE OF THE OPPORTUNITY

3.1 GOVERNMENT POLICYMAKERS AND REGULATORS

With an Open Access approach, government – at a national or local level – represents the public interest, particularly for the growth of the economy and a social responsibility for the less well-off. It needs to act as a fair referee on competition issues and create a level playing field for providers. It also ensures that the interests of the users of the infrastructure (both consumers and service companies) are well represented in any governance mechanism.

In this new light touch role government (and the autonomous regulators that implement its policies) have several key roles: to lower the barriers to market entry by removing as many unnecessary regulatory barriers as possible; to create a favorable business environment that offers investors enough certainty to develop their businesses and get a fair chance at a reasonable rate of return; and where necessary, to provide short-term "seed-funding" to encourage the risk-taking needed to expand the market.

The main purpose of this seed-funding would be to stimulate initial demand from public sector "anchor" customers, such as schools, health care facilities, and administrative departments on the basis of a sustainable, low recurrent cost infrastructure. This approach differs considerably from previous government expectations of telecoms licensing as a "cash cow."

If large-scale private sector companies will not or cannot provide service, government must offer this opportunity to local small – or medium-sized organizations in a supportive way to create the conditions for Open Access. Faced with this competitive alternative, the large-scale private sector company may decide to provide service to that area. If so, the government is then free to move on to focusing on another under-serviced area. In this sense, Open Access is both a strategic and tactical mechanism.

The government must be willing to underwrite the short-term risks involved in this "market-stretching" for either new entities or existing large-scale operators on an equal basis. There may also be parallels in the field of power provision where the same processes might be used to provide incentives to power roll-outs and investment. Indeed, it might be possible to bundle together incentives for both.

3.2 INTERNATIONAL DONORS

Financing Open Access calls for new ways of approaching the task. In the developing country context, the market will not necessarily by itself deliver cheap, widely accessible communications to all.

For donors, it is likely to be support for increasing demand where their funding may be relevant. Once they see that private sector funding has been maximized, they might get involved to provide part of this seed-funding. At a national level, they might underwrite activities that widen market entry and invest locally. Or at an international level, they might underwrite medium – to long-term risk on large-scale projects like infrastructure.

At the national level, donor money may be needed to assist with the transition from the current historic operator to the proposed infrastructure provider. This might simply be used to help clarify a strategic approach or be used for the purpose of more fundamental restructuring.

At the city level, municipal fiber network might be funded by private investment that simply connected business and high-income districts. If there was a "market-stretch" case for extending to a wider range of businesses and SMEs, this might be funded by the developing world version of a municipal bond. There are several sources of soft finance including the U.K. Department for International Development (DfID) and the Development Bank of South Africa that have loan schemes that would fit this category. A bonus included as part of the scheme might be a social dividend clause that would allow a percentage of the fiber to be accessible at

cost for hospitals, health clinics, universities and schools, providing a driver for them as customers of advanced services.

At the regional level for inter-country connections, private funding will be used, either in the form of bank loan or local equity. There will be a number of routes that do not attract commercial interest because the markets are too small and/or the political risks are too high. On these routes where commercial operators do not come forward, governments can then work with both soft loan institutions and donors to provide anything from 25 percent of soft loan funding to 100 percent donor payment on a given route. This process would be somewhat akin to the "reverse auctions" pioneered in the field of universal access in various developing countries.

At an international level, a number of different methods of structuring financial support are described in 2.7.

Support at all these different levels needs to emphasize the importance of the projects adhering to an Open Access approach with fair and transparent access being provided to all users. Overall, donors need to support both open, cheap backbones (supply) and user demand locally.

There are three ways in which the international community might play a role in furthering the practical development of these ideas:

- The changes that have created the potential for Open Access are relatively recent. Therefore, there is a need for an awareness-raising process among policymakers and regulators to help them understand what is happening in order to address its implications in ways that reflect the realities of their national situation.
- In order to generate impetus for the Open Access approach, it would be helpful to look at ways of prototyping the business models and financial mechanisms in particular: the role of municipal networks, open access and regulatory approaches, and the business model for rural micro-operators. This might be done at the national or international level in response to demand.
- At the local level, it will be necessary to create incentives for the development of local network equipment that will lower business entry costs. The most likely developers of these products are IP equipment vendors who are used to working with small-scale IP local area networks (LAN), open source and transmission control protocol (TCP)/IP. Whatever is created has to be open and well defined, which may make proprietary vendors less likely to be the driving force. Donors or others may need to seed a competition or incentive scheme to encourage these developments.

3.3 THE PRIVATE SECTOR

The private sector might be expected to do what it does best: innovate in ways that will help reduce the cost to users (and thereby increase its own profits); emphasize the widest use possible of different forms of communications and make investments (from local and national sources) where market opportunities exist. In exchange, it has the right to expect that government will create the kind of conditions described in 3.1 on the previous page.

At national, regional, and international levels, the private sector remains the investor of choice. It is important that donor money does not displace investment from the private sector but that the two are used differently to maximize overall investment in the sector. When the market risk is too great, new relationships with this division of responsibilities between governments and donors can create "market-stretch" funding that will speed up the pace of infrastructure development.

4. APPENDICES

APPENDIX A1: BACKGROUND READING

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APPENDIX A2: OPEN ACCESS MODELS FOR INFORMATION AND COMMUNICATION INFRASTRUCTURE – SOME BASIC PRINCIPLES

The Open Access approach suggests a number of key principles:

A2.1 Anyone can play

Open Access models should assure that any provider willing to play by the rules can "plug and play" in the network, particularly because of the potential for locally-provided services and network growth "at the edges" made possible by flexible technology and open network models.

A2.2 Technological Neutrality

Regulation should be technology-neutral, taking into account the cost and physical properties of the technologies themselves. No one should be stopped from using a particular technology and indeed a progressive regulator would encourage cost reduction through technology innovation.

One needs to recognize that in future a wide range of applications will require higher bandwidth. But there may be no significant (order of magnitude) improvements in the performance of fiber, particularly its installation. However with wireless there will be significant improvements in performance and cost/capacity ratio and therefore wireless solutions will become more attractive to the end user.

A2.3 Fair and non-discriminatory competition at all layers

A player at one layer of the network is free, within the framework of appropriate regulation, to do whatever it sees as most expedient within its own layer, as long as it provides the correct specifications to layers with which it interfaces. This allows a wide variety of physical networks and a large variety of applications to interact in an open architecture.

Competition should be fair and non-discriminatory. There should be no predatory pricing, cross-subsidization or aggressive cross-ownership. Regulators will need to be capable of dealing with a range of competition issues to ensure a genuine level playing field, and to prevent market strength in one layer from creating unfair competitive advantage at another layer.

For all services at a given layer, there ought to be at least two providers. Whenever there are not more than 4–5 providers of a particular service, issues of competitive position would need to be examined.

What is true for countries at a national level holds true at regional and international levels. Ideally, any country should have a choice of at least two providers to connect to neighbors and the rest of the world. The EU competition policy formulation of "significant market power" provides a useful benchmark against which competitive position might be examined.

A2.4 Transparency to ensure fair trading within and between layers

Competitive markets thrive on transparent information about market prices and service. Internal accounting processes in companies need to be sufficiently transparent to enforce fair trading. If there is tradable bandwidth – particularly at an international level – it will allow clear comparisons to be made between different providers. There needs to be greater levels of consumer information to allow comparisons between "offers," including offers at the interface between layers.

The different roles of players need to be transparent. In order to create trust in the market, infrastructure providers need to be clear that they will not enter service markets to compete with their customers. The regulator exists to encourage competition rather than restrict it but to do so in a way that genuinely encourages increased investment and lower access costs to communications technology. Where appropriate, regulation becomes "light-touch" rather than prohibitive or restrictive. Government exists to create the legal framework through which competition issues can be mediated.

A2.5 Everyone can connect to everyone else at the layer interface

In order for a competitive market to function, everyone must be able to connect to everyone else. Service providers would be able to get access to infrastructure from the local to the international level, whether they were small or large entities.

There will be inevitable interconnection rate issues where the interests of the infrastructure provider in keeping re-investing in the network need to be weighed against the opportunities that can be created for greater levels of new business.

A2.6 Devolved rather than centralized solutions

It is important to ensure that the "intelligence" in the network is to be found at the edges of the infrastructure rather than at its center. In other words, the infrastructure provider should not be allowed to reserve for itself all of the functions that create value in the market.

In practical terms, it should be possible to create a local entity that can operate on the small or medium-scale and can "plug into" the network without needing to cede control over its activities to the infrastructure provider. Local operators need to be able to own and control a significant level of "intelligence" in the system (e.g. billing, features, etc) to encourage open access.

APPENDIX A3: ORIGINS OF THE TERM OPEN ACCESS

The term Open Access means different things to different people and it is important to provide a summary of its origins before specifying how we are going to use the term. Different regulatory circumstances in the developed world account for several of the main differences in the way the term is used.

In the United States, the expression "Open Access" has been very much tied in a fairly narrow way to the debate about the role of Regional Bell Operating Companies (RBOCs): Will they be imposed (at cost) to provide different forms of unbundled capacity to competitors, particularly in terms of roll-out to the home? And why aren't cable TV companies being forced to meet a similar requirement as they roll out Triple Play?

In Europe the term has been used to address wider issues around access to the network and how the network might be financed and operated. Several Open Access initiatives (for example, municipal telecom networks) were started from the realization that it would not be financially possible to have several infrastructures in parallel in the local network. Despite this limitation, those involved still wanted to have competitive offers from several service providers. If there is only one network, then the terms under which companies can access it becomes a vital part of the argument.

However, the ideas are not just limited to the local network. Some nationwide power companies and other utilities have built substantial networks too within this framework of ideas, even if their interests are largely commercial: they only wish to become carriers' carriers, leveraging existing assets like power lines. They realize that they may not have the skills to enter the telecoms market except on a wholesale basis. Even some cross-border links were created within this same set of arguments.

In Europe regulators and operators have traveled a considerable distance in Open Access terms. Separation of services and infrastructure were initially viewed as impossible. Because of the way networks were previously technically structured, services and infrastructure were like Siamese twins that shared common organs. In Europe, Open Network Provision was a term that was first used in European Commission documents in the early 1990s, when rules were put in place to make sure other operators were able to get the most basic services from use of the historic operator's facilities. But issues like local loop unbundling were seen as too radical 10 years ago.

The separation of the network infrastructure was probably first discussed at length in markets that were early liberalizers such as Sweden and the United Kingdom. However, these ideas were quickly rejected at this time in France and Germany where the policy debate and the pace of change in the historic operator had not reached a similar point. The increasing introduction of IP-based networks and thinking means that even in the more traditional telephony world this separation is now occurring as a tool for rationalizing the operation of the business.

These discussions had their parallel in the United States where individuals and operators in the Internet sector began to talk about Open Access. The discussion focused on access to whatever network equipment was available (copper or cable) as a broadband delivery mechanism. Proponents of greater competition wanted access on a carriers' carrier basis with no price discrimination. This

demand echoed early U.S. legislation on access prices to railways. The counter argument is that the industry is now a liberalized, commercial market: different technical platforms are available that provide choice, however limited the scope. Demanding access at cost is nothing but theft of legitimate commercial profits, removing all incentives to further invest in new equipment.

Outside of these discussions within the Internet and telecoms industries, there is perhaps a wider echo of the use of the term in the debates around proprietary against open source software. The Open Source software arguments contain the idea of an accessible public core around which software services are built. The logical extension of these arguments has been into the field of intellectual property with the discussions around the Creative Commons approach to these issues. Open Access academic journals might be seen as a practical development of these arguments relating to intellectual property.

APPENDIX A4: BUSINESS MODEL AND TECHNOLOGY APPROACHES FOR SMALL-SCALE RURAL OPERATORS

This section looks at the contributory costs that would underlie any business model for a small-scale rural operator and examines a couple of technological approaches. Further work needs to be done in both areas but this material is provided as a starting point.

For well over 10 years, the cost of provided fixed wireline connections has been identified as around US$1000 per subscriber. One caveat to this figure has been that it is usually far more expensive to connect rural subscribers. Another caveat concerns what has been included in the figure.

In almost all cases, it has included the handset associated customer premises equipment (CPE), internal wiring, and the Central Office Main Distribution Frame. As networks – both at the local and distribution level – have been equipped with Remote Subscriber Stages (RSS), including the allocated cost of these items becomes more blurred: in particular as Central Offices become bigger and fewer.

The big cost driver in that part of the network is the length of the cable where 1–10 users are sharing. Obviously a low density of users is going to require more cabling. Buried cabling is three times more expensive than poles, and pole lines themselves are not cheap. At current prices in Tanzania, a low voltage pole line costs US$4,000 per km and building its telephone equivalent would cost roughly the same price. The average line length is above 1,500 meters in rural networks. Low customer density may also mean that the average for customers per household is not 0.5 as might be expected but closer to 0.1. This also tends to increase the cost of the non-shared parts of the line.

Another useful metric is financial sustainability based on Average Revenue Per User. Prior to the mobile explosion, various ITU studies identified an ARPU of US$300 being necessary for financial sustainability on fixed lines. This is quite close to the US$276 per year for Indian operators quoted in A.4.1 which follows this section.

With a 1000 sq km flat GSM site, the economics are very different. The key issues are: the construction costs; the backbone cost to reach the site; the sharing of operational systems and their scalability; upstream/interconnect costs; and probably most importantly, the cost of powering a local site. Maintaining diesel generators (particularly with back-up capacity) is expensive. This tends to be why operators such as Vodacom and others have been looking at solar-powered sites.

On this basis, the average capex per GSM subscriber in Africa is in the order of US$250 per subscriber. Therefore, any competing small-scale operation will need to be significantly below that price or offer added functionality to its users. However, this is against the backdrop that GSM equipment price has fallen by 15-20 percent over 5–10 years but African calling prices remain (on a per minute level) the same or higher than European prices during that period.

An attempt to lower the cost per subscriber below the threshold quoted above has to deal with three sets of costs:

- Transport from the town upstream and the cost of central systems.
- Local access, from a hub/node/base station site/CO in town and out to the user premises.
- Customer Premises Equipment (CPE).

If the local fixed hub/CO/base station site cost is high, it will have to serve many users to be able to lower the CAPEX cost per user. And we have not yet discussed maintenance and operating costs. If backbone transport demand at a district level is low (or very expensive or scarce), it is more likely that cheaper wireless transmission links will make financial sense.

Assuming fiber-based transport being made available to towns as part of a backbone structure at prices competitive to wireless links, the question still remains: Are the Optical Termination points (the ends of the fiber network) spaced a few kilometers apart? Several tens of kilometers apart? Or even several hundreds of kilometers apart?

In the last two cases, there would need to be additional wireless extensions to local hubs/base stations or very big footprints like CDMA 450.

Therefore, a cost-effective basis for small-scale local deployments is cheap, upstream transport to a point not more than 10–20 kms away, reachable by inexpensive wireless links and a local wireless hub at a significantly lower CAPEX than US$250 per user and Maintenance and Operating costs of the same magnitude as GSM. This includes central services for billing, etc., from a sub-contracted provider.

Currently there is a race between GSM and CDMA software and equipment providers to get more bandwidth out of their systems (thus deliver more subscribers at a lower cost) and the WILAN providers to scale-up various "bare-bones" IP-centric transport systems to provide both Internet connectivity and voice as an application.

Provided there are enough users in the town to sustain the broadband Internet service, then any access to individual users away from this centre will be on a cost basis that is lower than GSM costs. With a 3–5-km radius of coverage, individual users will be reached for a cost in the order of US$100 per subscriber (excluding CPE). The cheaper the upstream connection and the local hub, the wider the coverage possible through a "string-of-pearls" footprint.

If as is suggested below, a GSM front-end hub is used to enable subscribers to use the standard GSM phones (dominant in Africa), it will provide a voice and low bit rate data service. The question then is whether there are enough users to pay for such a service: either calculated on the basis of a monthly pre-paid ARPU or on the basis of a monthly pre-paid, flat-fee and with or without an international calling service, using VOIP.

Sharing a number of requirements is an important ingredient of the business model. Putting fiber on power lines (for monitoring and maintenance) that can also be used by any telecoms system will greatly lower the cost of roll-out and keep Maintenance and Operating costs down. A fiber connection to a town can also be used to distribute television and radio programming.

If the electrical power companies can see the sense of including fiber for their own control and metering purposes on the High-Voltage grid, it will be possible to get fiber out to the towns. If in place, it would add the potential for two additional income streams: leased capacity revenue on the fiber network and added power sales from a more dynamic local community that has access to ICT tools. The link between spreading power and telecoms together to outlying areas is not much discussed in either sector.

A small-scale, rural operator will need to have the following:

- Cheap backhaul/upstream, raw IP-transport, possibly shared on the transport level. This might be provided through: shared fiber cable; piggybacked on power grid; or by using Wi-Fi for transmission links.
- Electrical power, which means piggybacking on electrification initiatives at least the local grid level, if not at the national level.
- Local deployment (no truck rolls from town).
- Anchor customers from local public sector (any private networks for administrative purposes, including police, military, healthcare and education needs).
- An upstream service choice provided by local entrepreneurs.
- Wireline broadband as a minimum to the local town centre.
- Wireless for local access.

Two approaches to creating small-scale rural data and voice operations are described below. We are

not endorsing either approach as there are also a number of other approaches. But we provide these descriptions – one operational and the other potentially possible – to illustrate that it is technically possible to create the small-scale rural operations we describe.

A.4.1 n-Logue, India (CorDECT wireless local loop)

Small towns and rural areas in India have very little connectivity. With the cost of providing telephone and Internet connections being around US$800 per line, a revenue of about US$23 per month is required for an operator to break even. Access is affordable to barely 2–3 percent of Indian households, the majority already located in major cities

n-Logue is an Indian company that has spun off from work and research at and around The Indian Institute of Technology Madras (Chennai). Its delivers low-cost Internet and telephone services to rural village-based operators. n-Logue's business model is already available in large numbers of villages across India. The system is also in use in Nigeria, Madagascar, and Tunisia.

At the local level in India n-Logue identifies and partners with local entrepreneurs. These local service providers find subscribers, provide services, and collect payments. At the village level there are kiosks, which provide services and information aimed at the rural market.

The technology n-Logue uses – corDECT Wireless Local Loop – provides a simultaneous telephone and 35/70 kbps Internet connection to a user at a per-line access cost of about US$180. The next version of corDECT will deliver 256 kbps. It can also offer a "Minnow" ISP-in-a-box software, which requires a considerably lower initial investment. These cost savings enable a small operator to invest and provide services in a limited area, and make incremental expenditures as the total number of subscribers grows. The system can serve between 1,000–1,500 people in a radius of 25 km.

Each Access Centre includes:

- a leased Internet connection to the nearest Internet gateway,
- a 60' tower with multiple Compact Base Stations to transmit the corDECT signal,
- a DECT Interface Unit and Remote Access Server for routing Internet and voice data,
- radius, Network Address Translation and Domain Name System servers, and
- software to bill customers on a monthly basis and track the payments.

Each village kiosk costs approximately US$1200 to set up, and includes:

- a wall set that receives the wireless corDECT signal,
- branded PC with 15" color monitor,
- computer peripherals including speaker, microphone, CD-ROM, digital camera, inkjet printer and sound card,
- UPS with battery providing 4 hours of back-up power for PC, and
- an application suite consisting of word-processing, browsing and e-mail software all in local language as well as in English.

If telephony is available in the project area, the cost of the kiosk increases by USD$110. A number of the village kiosks provide a phone service, often the only one in the village. At a village level the operation reaches breakeven at a remarkably low revenue level: just over US$3 per day. At the local service provider level, the business risk is shared between n-Logue and the local operator.

Small capacity GSM base stations can be installed at the village kiosks with a maximum signal range of in the order of 2 km. A business model for the deployment is under development, but services will be offered at extremely low per minute charges – as low as US0.5–1 cent per minute. This is less than half the current fixed line tariff in India. The local service providers will accommodate the GSM network centre, using the existing CorDECT wireless facilities to carry the telephone signals from the villages to the switching centre.

The village operators will be given a new role as agents of the GSM operator, providing customer support, managing accounts and payments etc. This will improve their revenue base and add to their financial stability. Similarly, the n-Logue the local service providers will act as agents of the GSM operator, providing connectivity services between the village BTS, the switching centre and the national networks. Needless to say, this new

business model presents Indian regulators at the Telecom Regulatory Authority of India (TRAI) with a new licensing challenge. Although it has published papers in support of the idea the issue has not yet been resolved.

n-Logue's business model depends heavily on the relatively high rural population density found in India. As many as 480,000 people can be found within the 25-km radius that can be reached by the CorDECT local wireless loop. Many of these villages have access to a local electricity supply. Rural population density in Africa is typically much lower and local electricity supply is the exception rather than the rule. Small scale entrepreneurship is less developed in Africa and local capital is not easily available.

A.4.2 A "GSM-lite" network utilizing IP technology

GSM-Lite is not yet fully operational but describes how it would be possible to build small yet scalable cellular networks using off-the-shelf IP hardware and standard GSM terminals. It is inspired by two market trends. The first is the unquestionable success of the GSM standard as the dominant technology for cellular networks. The second trend is the growth of use VoIP or session initiation protocol (SIP) for carrying calls. In comparison to the model in 3.1.1, it connects a local GSM cell directly to a generic wireless (or other) IP network.

The latest GSM specification allows IP to be used for part of the core network and future upgrades will include IP for all or part of the backbone. There also products that will allow the creation of a radio access network using IP. However, these innovations only go part of the way towards building the network envisaged.

A GSM network is expensive to deploy because it is set up for hundred of thousands of subscribers rather than for micro-operation, is extremely fault tolerant, and built using hardware that is produced in low quantities.

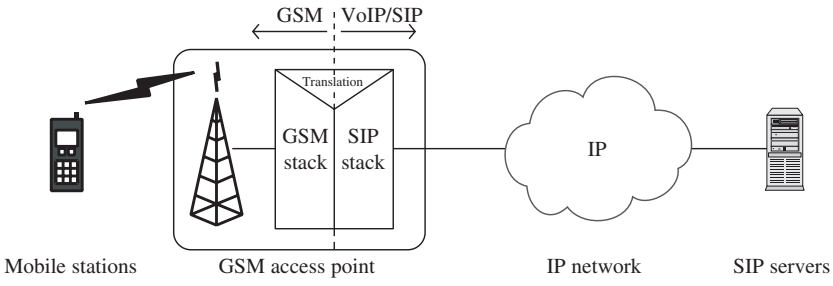
Therefore, to achieve a "GSM-lite" network one needs to be able to produce something that will work with only a few hundred subscribers and uses cheap, off-the-shelf software and existing or new IP networks that can run other services like Internet access. As it runs on the dominant technology, second-hand handsets can be sourced at between US$20–$25.

To achieve this, it would be possible to create what might be called a GSM access point (GSM-AP). The GSM-AP connected to an IP network and translates from GSM to VoIP/SIP. An overview of the system is shown in diagram 3.

The access point will act on the wireless side as a GSM base station but also terminate all GSM signaling. On the network side it communicates using SIP based VoIP. This would allow building of a very small network and use of regular CPUs and an Ethernet network card. The only dedicated GSM hardware would be the base station.

A GSM terminal attached to the access point will be represented as a SIP client on the network side. The SIP client will do authentication, call request, and negotiate media codecs. This means that the infrastructure needed on the network side to handle call management is not much different from any other SIP infrastructure.

DIAGRAM 3: GSM lite overview



The GSM-AP must of course emulate a whole GSM network as the GSM terminal will therefore not need to be changed to accommodate interconnection. This mainly involves it being able to handle radio resource issues, authentication, mobility, paging, and call management. The other issue is how to do hand-over from one GSM-AP to another since the system should not be limited to one base station. Preliminary studies indicate that this functionality can be implemented in the GSM-AP.

This example illustrates that it may be possible to create a technological solution to create an even lower cost-entry model than for the previous example. And although there is no working business model, many of the same approaches used in India can be used or modified for implementation. Local service providers can get roaming agreements with national operators to extend their coverage and allow local users to go to other places and use their phone.

However, the lack of entrepreneurial capacity in rural Sub-Saharan Africa remains an issue. It would be necessary to negotiate a GSM software license and intellectual property will be a major issue. Current GSM license costs reflect market realities of much larger subscriber bases. Nevertheless, the license cost exemptions negotiated by developing countries to produce HIV/AIDS drugs clearly sets a precedent that can be pursued. From initial discussions we believe that there would be a rapid technical development. The take-up of services may not recapitalize first generation capital investment but that after that point would begin to become self-sustaining. The aim would be to build a market as it went into its second generation based on around 30 percent of rural users.

APPENDIX A5: MUNICIPAL NETWORKS — BACKGROUND INFORMATION

Municipal networks exist in a number of countries (a few examples include France, Germany, Netherlands, Finland, Sweden, and the United States) and in certain circumstances have been quite effective in promoting the developing of city or municipality-wide infrastructure growth.

A5.1 How municipal networks arose and their characteristics

There are no markets with more than two fiber cables because, from a business point of view, it is difficult to justify duplication. As any new system, whether mobile or fixed (narrow or broadband), depends on fiber in the backbone, the unlocking of the market starts here. Although piecemeal duplication (and swapping) in some U.S. and European metro areas sometimes give the impression that there is more than one fiber system, fibers often described as separate networks end up being in the same cable.

Although it is not clear what drew all of the players into the market, most have sought through swapping capacity to try and become vertically integrated and put themselves in a dominant market position. Or the players were providers of Open Access dark fiber who later decided to enter other markets. Whatever their motivations, they both added capacity to the market in such a way that fiber became a commodity in and between metro areas and people begun to trade it.

However, outside of the financial districts of metropolitan authorities, there may be only the historic operator or the choice between it and a cable TV company. In rare instances, there is an occasional Open Access provider like a local utility company. For understandable reasons, private investors do not seem to favor putting money into broadband provision beyond metropolitan areas.

U.S. studies indicate a correlation between being close to a metropolitan area and local utility interest in telecoms. They highlight the importance of a shorter and cheaper backhaul to a node in the city, and demand from a wealthier and better paid population. Other studies take a very different view. They focus on rural communities that consider being connected to broadband as a matter of survival: they do not want to be left out of the information society. Rural development funds and other support mechanisms have tended to encourage these broadband developments.

Depending upon where the champions of an alternative telecom infrastructure come from, the form of the operation, its organizational framework and goals may differ. The majority of alternative telecom infrastructure initiatives are locally driven by a

combination of broadband activists, politicians, and utility executives. The balance among these groups can differ. Activists tend to argue for the importance of the issue but it is the politicians and utility executives who have the means to implement initiatives.

The involvement of electricity utility companies comes from the fact that it often operates a fiber-based communications network to run its own business (controlling the electricity grid) across a range of different sites. They can see that, from a technical point of view, they could supply the same bandwidth to others, particularly to those with whom they already have a closer business relationship. If, as in some cases, the utility company is owned by the municipal authority, there is often a mutual relationship that has a similar basis. But the next step – supplying a wider set of customers – is more complicated from a business model, regulator, and charter point of view because of the following factors:

- The utility company may not have its Rights of Way for any other purpose than providing electricity.
- The utility company may violate other legal requirements like the separation of businesses, prohibiting the use of its funds for telecoms, or the use of its data from its customer base for other purposes.
- The company's charter may not allow it to offer external telecom services.
- Other legislation may prevent it from going into telecoms.
- Separate accounting, or other administrative demands may be mandatory to the point that the associated costs and the requirement to account separately for them may be a disincentive.
- Almost no utility company has any experience in telecommunications.

A5.2 An early municipal network development (Stokab)

Stockholm municipality set up Stokab in 1994 to meet the demand for fiber that was generated by the complete liberalization of the Swedish market. Dozens of new operators set up because they did not need a license. Because they were not in a dominant position and had no need of spectrum, they just had to register their company and get a VAT number. All the new entrants needed fiber that the Swedish historic operator initially refused to provide. A major factor in this initial growth in demand was a desire by private sector players to test what was possible in a completely liberalized environment where anyone could offer any service.

Therefore, the purpose of Stokab was to facilitate and stimulate sector investment and innovation in the region. Once set up, the company expanded the network into 27 surrounding municipalities. A strategic decision taken when operations were commenced was that Stokab would only offer the market the fiber-optic infrastructure ("dark fiber"), the asset that is most difficult to replicate and leave services and innovation using the fiber to the new telecommunications companies. This decision was a key guiding principle of the company.

The slow decision-making process of the public sector municipality would never cope with the rapid changes needed to enter other markets. Also the existence of other potential players higher up the value chain would have politically killed any attempt to move beyond this original purpose.

Initial network deployment responded to a pent up market demand in the more lucrative commercial areas, first in Stockholm's inner city (only a few square miles). Subsequently, it expanded to an increasing number of surrounding areas. Competition soon made its final consumers the real winners. Big commercial customers such as 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. In the mid-1990s there was not a strong demand for fiber-based broadband services for the consumer market: video on demand in its early form had just failed in test deployments. No one was expecting IP to be the universal platform among the service providers.

Today it has connection points in all municipalities in the county, covering 6,500 sq kms with spurs into neighboring counties. The network is today more or less developed within a number of municipalities to provide an alternative fiber option to areas with commercial customers. It also offers a backbone structure to rural areas, reaching schools and housing complexes, and connecting wireless sites. After the initial creation of a backbone "footprint" and commercial district access, it

sought to increase the number of individual customers using the network. This needed a much bigger investment to also reach more price sensitive residential users.

Fiber 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 a fiber on an open access basis to every house on their grid.

What was argued by the historic operator (in early 1995) to be a deterrent for any roll-out of fiber in the local network became the opposite. The supply-and-demand chain became more vital and the historic operator was pushed by market forces to roll out more fiber too, further fuelling the process. Service providers all of a sudden had a choice, lowering their perceived risk in buying infrastructure capacity. The benefit of this is clear today when some customers are able to make a less emotional evaluation of their choices in a competitive market. The historic operator is looked at very differently, particularly as Stokab has suffered from a period of management-related problems. This has not really dented the market but many have changed fiber supplier.

The key issue for both fiber providers is to expand the fiber network closer to the single end user, ultimately the residential customer, with one eye on the growth of high-bandwidth hungry services and another on wireless access developments.

In more rural areas in this 6,500 sq km county, Stokab did not see itself as a provider of transport services over any wireless network. With a fiber backbone over the entire area, the question came up after a few years how several providers could provide wireless access in competition. However, as spectrum allocation was based upon an old model, Stokab applied for, and got, 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 such as Wi-MAX still have teething problems. Furthermore, asymmetric digital subscriber line (ADSL) is now available as an unbundled service, and this lowers the entry cost for any contender wanting to build market share.

The expected driver of growth is "triple play" (phone, Internet and broadcast) to the residential market. Low-speed broadband access for voice and surfing has become a mature market. The next major driver for greatly increased capacity will be digital HDTV as a part of a triple play bundle that will trigger the next development phase. And this may encourage both Stokab and the historic operator to enter the market to fulfill this demand.

During its first years, Stokab was not building access to every home, speculating on a future demand. Instead, it sought to develop in step with demand. It went first to commercial users in the downtown area, then to smaller users and farther out into less dense areas. In this it was different from some of the more recent proposed alternative infrastructure providers (see below) who are promising a "fiber to all buildings in town" approach. This approach responds to the anticipation of new applications and more widely available broadband mass market equipment.

A5.3 Rural municipal providers (UTOPIA, iProvo, and Zipp)

Alternative service providers in the United States provide an interesting contrast to the Swedish experience. Several municipalities in Utah created what is known as the UTOPIA network through building a mixture of fiber and wireless infrastructure with some transport services on top. The network required cooperation among several municipalities. This has been complicated by two factors. First, there has been a mismatch between the aspirations for a network and the political situation in different municipalities: not all shared the same understanding of what they were trying to achieve and how far they wanted to commit themselves. Secondly, there were a series of legal battles with incumbent operators, mainly arguing that it was a risky gamble with taxpayers money into an area where there were several private investors to find. The argument was also that financing through municipal bonds was an unfair advantage, providing cheaper access to capital than that available to a listed company.

After a couple of years of debate, including modifications of the initial plans, the first phase is now under construction. To ensure service providers find the 750,000-person market viable, UTOPIA went up the value chain offering not only dark fiber but a transport network, hubs and head-ends. In this way they lowered the entry cost for potential service providers and in so doing reduced the perceived risk of entering the market. Even so, it is an Open Access model at higher network level.

A major setback was that the largest city – Salt Lake City – opted out, leaving just 14 cities and a considerable smaller customer base. UTOPIA is interesting as it has been one of the best documented prominent battlefields between incumbent interests and local Open Access approaches in the United States. It illustrates how the U.S.-specific regulatory framework, governance, and market legacy tend to restrict or actively run counter to Open Access ideas. However it has also seen a rehearsal for some of sharpest proponents both for and against the idea of municipal networks.

In the case of the town of Provo, it decided to go it alone (calling its network i-Provo) after a series of legal battles. The key internal issues in the dispute were about where resources might be invested and which areas would be first to see benefits from them. But these internal issues have been rather overshadowed by the broader dispute about whether municipal networks should exist or not.

Provo shows the difference a strong local power distribution utility can make under otherwise similar conditions. The iProvo network is not only operationally, but also financially under the utility's wing. A well-functioning utility as a champion and home for the new venture is probably an easier "sell" to the public than "a new political pet project in City Hall." The fact that some real savings in local electrical grid upgrades can be done simultaneously with building out fiber is definitely a plus as this is the most expensive part of both operations.

Both UTOPIA and iProvo are still in early phases so it is too early to judge their future success. The fact that the two have similar attitudes on how to relate to the market, and have agreed to co-utilize some head-end equipment, indicate that they will have the advantage of a combined customer base, when evaluated by prospective service providers. Comments from a few of these service providers indicate that the two together reach the critical mass of 200,000 to 250,000 people.

The case of Grant County, WA, with its Zipp network, is illustrative as an example of an area with large rural portions where a power utility was also the starting point for a fiber roll-out. In an area of approximately the same size as Stokab, Grant County has a population of 78,000 against 1.3 million for the Stockholm area. As a result, it has been much more of a challenge to make it work.

The average cable length per home, and associated cost is correspondingly much higher. It is also visible in the fact that the Zipp network is needed to invest higher up the value chain. The market was probably not big enough for investor-driven companies to take all the risk as service providers by themselves. Some commentators claim that a high turnover among Zipp's service providers also relates to the small market. In its sharpest form, the dilemma for Zipp is how to get its12,000 or so users to pay for a US$1 million investment in network head-ends. Perhaps this illustrates the limits of municipal fiber roll-out where subscriber numbers do not yet provide the ability to repay investment to the public sector. Core equipment, head-ends and hubs need to be cheaper per user, and the cost per home passed needs to come down, suggesting more wireless for access in rural areas.

A5.4 A recent municipal network initiative (Amsterdam)

Recently, the Amsterdam Municipal Development Corp. put out a tender for private companies to compete for connecting the city's 450,000 companies, organizations and homes. Although local private operators believe that it will destroy the market (or at least their position in it), discussions continue. The situation is markedly different to that of Stokab, even if the two operate under the same EU regulatory framework and both address a 1.5–2 million metropolitan population.

The process has been started much later and there are now a greater number of new operators, although their networks do not meet the aspirations of the municipality. There are not only competitive tensions with the telco incumbent but also with cable TV networks, as you might expect in a

more developed market. The cable TV companies, like the telco, wish to modernize their networks to offer "triple play". The upgrades are more related to the electronics than a massive transition from twisted pair or coaxial cable to fiber. A competing fiber structure will no doubt remove any relative advantage the two have over non-facilities based competitors but also change their relative positions.

With HDTV being close to deployment over IP in fiber-based alternative networks elsewhere, including in Amsterdam suburbs, it is easy to understand the cable operators' fears. Their old networks will have a hard time once this happens, as they can hardly carry 30–100 Mb/s per household.

The city has taken on the responsibility for setting up an independent legal entity – Citynet Amsterdam – which will be the vehicle for the investment and own the passive network and will also invest in the transport layer. Private partners have been invited to supply the infrastructure equipment and operate the transport layer of the network on an Open Access basis. The structure is no doubt influenced by the debate around city involvement, but also EU state aid rules and EU development funds. An express part of the purpose of creating the network is to create low prices for users.

As the cases of Amsterdam and UTOPIA show, municipal networks are the subject of intense policy debates. However the ideas can be adjusted to different competition rules and other national and international requirements, making whatever they do not only legal but also eligible for development funding.

Besides making fiber available for other service providers, there is also a growing trend among heavy users of communication services, such as banks, data processing centers and universities, to run their own operations by just renting the "dark" fiber. Several EU universities actually run considerable research traffic entirely on their own between campuses and often across borders. The volumes may be low or sporadic, but their capacities are in some cases far more than what their entire country had in Internet traffic just a few years ago.

In many cases this is no more complex than running the LAN inside the campus. For a heavy user with the required skills, there is no point in involving an operator to connect a few sites that are relatively close (20–50 km apart) if there is a competitively priced dark fiber around. Stokab, mentioned above, has business with 50 plus operators, but also considerable business with end customers just wanting a dark fiber from A to B in the metro area. This is an example of how customers are integrating backwards when technology becomes cheap. A pair of 20 km 1 Gigabyte (Gb) communication cards is no more expensive than an operator sales call. Service operators cannot take anything for granted about their market position even if they have been helped with cheap fiber.

It is also notable that many U.S. municipal initiatives being contemplated do not tend to deploy much fiber and are more likely to use wireless as a means of access than their European counterparts. U.S. demographics are no doubt a strong element in this: U.S. suburbs sprawl out and rural areas are thinly populated. In that sense the parallels with rural Africa are closer than with say, the densely populated urban Netherlands. Also with places like the rural inland area of northern Sweden and Finland, where population density equals that found in the Sahara desert, wireless is a strong complement to fiber as the means of access.

A5.5 The case of state finance (ATLAS)

In Europe, the case of the ATLAS network in Scotland is also illustrative of the policy issues involved. The investment of state aid through a Scottish development agency for a business-park oriented broadband roll-out, an associated regional hub and back-haul to a major hub, spurred formal questions to the European Commission (EC). Its immediate response was that any network using state aid needed to be for "the common good" and was only justifiable if no one else was going to build the network. It later also reiterated that there must be open access to the infrastructure built to all players on an equal basis and that structural funds must only be used to build the lower layers, essentially the physical layer. This prompted considerable redesign and a more limited scope.

The EC is expected to publish a policy paper later this year addressing questions of how to define the extent of market failure and the involvement of public money in these instances. In the meantime,

the ATLAS ruling and the EU DG Regional Guidelines must be considered key elements in the use of any EU public funds into telecoms for regional development. Both stress involvement in lower layers only and open access.

For the purposes of developing country discussions, the key policy issues are clear. In most developing countries (particularly in Africa) there are no competing infrastructure providers: for example, cable TV operators. If a municipal network is considered a useful option, it would be important to tender for its development to allow any potential private investors to step forward and clarify their intentions at that point. In addition, mergers of the state assets of other fiber providers and those of the historic operator should be considered.

If the network constructed stays at the transport layer, or below, and if it offers open and fair access to all then it would clear the two policy tests set by the European Commission. Circumstances in the United States are much more complicated for the purposes of comparison because of the existence of federal, state and local levels of government and also separate regulatory frameworks for each sector (phone, cable TV, and broadcast).The Open Access approach does not seek to emulate particular national circumstances but draws upon best practice as it develops.

For European donors, the issues raised by the EU judgment on ATLAS are important. Any contribution they make to infrastructure development would have to follow the principles outlined by broader EC policy on these issues.

However, in the new market with an ever-increasing vertical separation; fixed and wireless access; bundling of services in new ways; and a growing number of players in complex relations, donors must find sustainable principles when considering sector support. It is highly unlikely that these will differ a great deal from what has been found in those countries where public money has been injected to speed up Broadband availability after the liberalization of the market.

Supporting local involvement in roll-out will also create a different division of roles for central and local governments. The rules and regulation becomes more of an issue for central government and implementation a local responsibility. In countries with weak structures this may be both good and bad. The championing of networks of this kind may help to drive broader competition and modernization agendas at city and district levels. On the down side, there are awkward issues around political patronage and corruption that will need to be looked at when considering the success of any model proposed. The most obvious route is to ensure that end-users are involved in the governance, giving them a strong incentive not to cheat.

A5.6 Arguments for and against municipal networks

In the United States, there are bills mandating local referendums. Others under consideration would force the municipalities to ask the historic operators "permission" to build the networks to substantiate that there is "market failure." But because of ambiguities surrounding the circumstances when this is deemed to have occurred, it may not actually encourage roll-out from either party. Those arguing against municipal networks in the United States say that there is no market failure whatsoever and the municipalities (and others) should allow the market to operate effectively by just staying out of it.

The fact that municipalities are more involved in the lower layers of telecommunication is also illustrated by a recent report to the mayor of New York, the world's most dense telecom market. This report calls for the city's involvement, including making funds available, in creating lateral conduit in the streets of Manhattan for all operators to use, supporting hubs and redundant fiber rings, and also providing tax breaks for dual fiber cable entries and risers in large buildings.

The debate over the financial effectiveness of municipal build-outs has clearly been clearly distorted by supporters and opponents, each having a problem with the view the other takes of the U.S. telecoms industry.

Opponents claim that municipal networks are a financial disaster since they are not generating immediate profits. Also, as they have access to cheaper funds than private investors, they have unfair advantage of cheap Right-of -Way, less red tape in the administration, and so on.

Supporters point out that it is a long term investment in passive infrastructure over 15–25 years and that it will take 5–7 years to start making money. Furthermore, they cite the example of Cable TV operators who needed 5–10 years to get profitable. Their key point is that you simply cannot get immediate profitability in a network industry until the larger part of the network is built and there is a critical volume of customers as takers of the service.

The other key difference between the two sides is that the overall goal for the municipal network is not to maximize profit for its owner as soon as possible, but to keep its own profits low in order to offer low rates to users. In effect, the municipal networks see themselves as acting as proxies for users.

The financial benefit of cheaper capital was of more importance in the high interest rate economy of a decade ago. Today it is overshadowed by demographics (average cable length per home passed), take rate and operational efficiency. It is true that there is a cost advantage to close operational cooperation with another network utility in the area, but civil works remain the lion's share of the investment.

However, the key issue remains whether the municipal network can generate enough trust with the other players higher up the value chain to make them invest and compete on their levels. If it can, the accumulated revenues of all the service providers will be higher than for an individual provider because end users want to have choices. Therefore the co-utilization of the underlying infrastructure will be better for a commonly-held municipal network.

This is the main factor that significantly influences the equation one way or the other. Technology choices and operational skills will be less significant if it is assumed that the operation will be run by professionals. A poor level of revenue in low population density areas cannot be compensated for by other factors. As making ends meet is difficult even in high income, high density areas it is an issue in many places as to how to proactively get a better infrastructure out for all private investor service operators to compete on. The inevitable question is to what extent should this be subsidized when the business plans for this type of municipal network lacks short-term revenues and may even have revenue difficulties in the medium to long-term?

APPENDIX A6: GLOSSARY OF TERMS

Terms are listed in alphabetical order:

Accounting rate system: This is the mechanism for sharing the cost for international calls between the sending and receiving carriers in each country, so that each side pays half of the cost of the international circuit.

IP network: Short for Internet Protocol. IP specifies the format of packets, also called datagrams, and the addressing scheme. Most networks combine IP with a higher-level protocol called Transmission Control Protocol (TCP), which establishes a virtual connection between a destination and a source. IP by itself is something like the postal system. It allows you to address a package and drop it in the system, but there's no direct link between you and the recipient. TCP/IP, on the other hand, establishes a connection between two hosts so that they can send messages back and forth for a period of time. The current version of IP is IPv4. A new version, called IPv6 or IPng, is under development.

CDMA: Short for Code-Division Multiple Access, a digital cellular technology that uses spread-spectrum techniques. Unlike competing systems, such as GSM, that use TDMA, CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence.

EDGE: Acronym for Enhanced Data GSM Environment. EDGE is a faster version of GSM wireless service. EDGE enables data to be delivered at rates up to 384 Kbps on a broadband. The standard is based on the GSM standard and uses TDMA multiplexing technology.

Triple-play: Internet, TV and telephony.

VoIP: Voice over Internet Protocol which allows people to use the internet as a transmission medium for telephone connections.

VSAT: Short for very small aperture terminal, an earthbound station used in satellite communications of data, voice and video signals, excluding broadcast television. A VSAT consists of two parts, a transceiver

that is placed outdoors in direct line of sight to the satellite and a device that is placed indoors to interface the transceiver with the end user's communications device, such as a PC. The transceiver receives or sends a signal to a satellite transponder in the sky. The satellite sends and receives signals from a ground station computer that acts as a hub for the system. Each end user is interconnected with the hub station via the satellite, forming a star topology. The hub controls the entire operation of the network. For one end user to communicate with another, each transmission has to first go to the hub station that then retransmits it via the satellite to the other end user's VSAT. Although this is the most common topology, others have been developed.

Wi-Fi: Short for wireless fidelity and is meant to be used generically when referring of any type of 802.11 network, whether 802.11b, 802.11a, dual-band, etc. The term is promulgated by the Wi-Fi Alliance. Any products tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as interoperable with each other, even if they are from different manufacturers. A user with a "Wi-Fi Certified" product can use any brand of access point with any other brand of client hardware that also is certified. Typically, however, any Wi-Fi product using the same radio frequency (for example, 2.4 GHz for 802.11b or 11g, 5 GHz for 802.11a) will work with any other, even if not "Wi-Fi Certified."

Wi-MAX: Wi-MAX is the trade name for a family of new technologies related to the IEEE 802.16 wireless standards. Wi-MAX has the potential for very long range (5–30 miles) and high speeds.

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