Rural Broadband Backbone: A case study of different approaches and potential

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This case study looks at different approaches to extending fibre backbone into rural areas. Market forces alone are unlikely to extend optical fibre backbone into rural areas, where access to high bandwidth and reliable internet access can contribute significantly to a comprehensive pro-poor ICT policy. Even more than in urban areas, high bandwidth services such as videoconferencing can open opportunities to poor communities in terms of service provision and communication and can also support the aggregation of usage of low-bandwidth services such as e-banking, VoIP telephony and delivery of some public services.

There are various options for the provision of rural broadband backbone, from direct investment by a government-owned operator (as in India), to the provision of "open access" fibre backbone through a public/private consortium (as proposed in parts of Africa), to mechanisms that encourage infrastructure sharing and build complementary infrastructure. Funds can be raised through a variety of universal access mechanisms, and significant savings are possible through providing shared backhaul services to mobile operators who otherwise tend to build low-bandwidth dedicated solutions. Once fibre is available to rural communities, further mechanisms can be designed to extend the services and benefits to poor users.

Introduction

The roll-out of fibre backbone[1] to rural areas can significantly contribute to building a pro-poor ICT policy, and the need for this roll-out is increasingly recognised.[2] Although the less costly and speedier option of wireless backbone is growing in bandwidth capacity, nothing is likely to approach optical fibre in terms of future-proofing the volume of traffic handled and the range of services carried. Rolling out that backbone and allowing access to it in appropriate ways are necessary conditions for building a huge range of possibilities to use ICT to address poverty.

This case study looks at two examples of fibre backbone that have been, or are being, brought into rural areas. They may not offer a definitive guide for "best practice", but do raise the issues that must be addressed if at least "good practice" is to be reasonably defined.

The challenge for rolling out backbone into rural areas is that the cost per user is much higher than in urban areas, since the population is dispersed.[3] As a result, commercial operators are less interested in covering rural areas. The concentration of commerce and administration in urban areas also tends to generate greater demand for connectivity.

Two key assumptions:

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1 "Backbone" is that part of the telecommunication network that never reaches the final customer directly, but is used to link together local access networks that offer a range of services, and to aggregate demand and carry it efficiently over long distances. Backbone has national and international components. The former is considered here.

2 Spintrack AB *Open Access Models: Options for Improving Backbone Access in Developing Countries* (Washington: infoDev/World Bank, 2005) www.infodev.org/en/Publication.10.html; Williams, Mark *Broadband for Africa: Policy for Promoting the Development of Backbone Networks* (Washington: *info*Dev/World Bank, 2008) www.infodev.org/en/Publication.526.html

3 "Rural" in this context may include many major towns that are, however, distant from the main metropolitan areas. For instance, in Uganda the fibre network is concentrated in the south where most users are. To connect ten more major towns elsewhere would cost 180% more per unit (of bandwidth) than it does in the south. The cost is driven up by both longer distance and lower anticipated levels of use (Williams *Broadband for Africa*, 38).

- In the longer term, the availability of high bandwidth in rural areas might reconfigure the potential of commercial, administrative and service activities there. It might generate a better overall rural/urban balance and contribute to poverty reduction.
- In the short term, the availability of bandwidth in rural areas might yield considerably higher demand for this bandwidth than is currently anticipated. This was the case for telephony.

We cannot validate these assumptions yet, but some evidence suggests that the second assumption, at least, might be true. An analysis in India suggests that operators rolling out fibre networks are finding many areas more viable than conventional calculations would show.[4]

Of course, fibre is not always the optimal solution to providing broadband in rural areas. Where vast distances must be covered to reach extremely dispersed populations, satellite networks may still be the best option, even in the longer term. Furthermore, fibre is unlikely to constitute the "last mile" up to actual rural user premises. Various wireless technologies, such as WiMAX, can provide blanket high-bandwidth coverage to users within quite a wide area, or can be focused to carry bandwidth over longer distances, connecting the fibre to wide swathes of the territory it passes through. But the more bandwidth that is aggregated together by these means within rural areas, the more sense it makes for fibre to ultimately link them into wider networks.

The majority of the cost of laying fibre is in the physical works, not in the fibre itself, emphasising the advantages of sharing passive infrastructure such as telephone poles and train tracks. It also means that huge redundancy (or overcapacity) can be, and usually is, built in with minimal cost through adding additional fibres. This reinforces the case that, just as with motorways, it makes little sense for multiple competing optical fibre "highways" to be built in parallel. Policy should instead ensure that all users, especially in rural circumstances, can affordably gain access to these backbone highways. From an equitable access standpoint, the question is also what additional measures must be taken to ensure that poor communities, in particular, can reap the benefits and gain access themselves. To continue the motorway analogy: those who cannot afford cars benefit little, indeed they often lose. Perhaps a railway, in this context, is a more suitable (and sustainable) analogy in terms of service delivery roll-out and demand stimulation. An "end-to-end" approach to pro-poor advocacy and planning is required: policy that emphasises broadband roll-out alone may not, in the absence of actions to support local service development and usage, result in better and more equitable access.

Rural backbone in India

It is claimed that every village in India is within 25 kilometres of optical fibre backbone,[5] which suggests an astonishing degree of success in such a vast and varied country. The fact that so few villages are actually connected to it, and that the fibre is hugely underutilised, suggests that this success must be somewhat qualified.

Access Deficit Charges

As competition was introduced into the Indian market, a system known as Access Deficit Charges (ADCs) was established. ADCs are funds given to operators to compensate for the difference between the actual cost of providing a service, and the (lower) tariff that the operator is obliged by a regulator to charge. Since BSNL was by far the largest supplier of rural customers, where the cost of providing service is usually more, the ADCs worked strongly to its advantage. Despite the Telecommunication Regulation Authority of

[4] Harsha Vardhana Singh and Rohan Samarajiva "Chapter 7: One Backbone, or Two?", in *ICT Infrastructure in Emerging Asia: Policy and Regulatory Roadblocks* eds. Rohan Samarajiva and Ayesha Zainudeen (New Delhi: LIRNEasia/IDRC/SAGE Publications, 2008), 125 www.idrc.ca/openebooks/378-2

[5] See slide 13 of a presentation by an IT ministry official at www.cu.ipv6tf.org/casos/mcit-ipv6-2004.pdf

India's (TRAI) efforts to reform the system, BSNL remains by far the greatest beneficiary, though the amounts have sizably shrunk compared to what they were.[6] By one calculation, the amount early on could actually reach 30% of the entire sector's income.[7]

Using some of these funds, BSNL invested heavily in extending further its already substantial rural fibre-optic network. By 2006, BSNL had over 450,000 kilometres of fibre, compared to about 65,000 kilometres of its nearest rival, Reliance.[8] Very little of commercial operators' networks reached into rural areas.

Universal Service Obligation Fund

In addition to ADCs, a Universal Service Obligation Fund (USOF) was established under the Department of Telecommunications in 2002. It was generously endowed with 5% of gross revenue of all operators,[9] second highest in the world.[10] By March 2005, the USOF had accumulated INR 72.54 billion (about USD 1.6 billion), of which about 25% was spent or pledged.[11] As in other parts of the world, a least-cost subsidy auction approach was adopted to build networks of subscribers in rural areas (initially covering only fixed line and fixed wireless in the local loop) and connect them to the national network,[12] as well as to supply community phones and other elements in the network. The fact that BSNL already had access to a low-cost backhaul fibre network gave it the edge over competitors, whose reach into areas for which the subsidy was offered barely existed. As a result, BSNL won the lion's share of the auctions and of the USOF funds.[13]

Impact

The way in which the ADCs and the USOF were deployed has been criticised on various grounds. While the USOF did lead to an increase in rural fixed-line access, it failed to reduce the urban/rural teledensity disparity.[14] In addition, neither offered any incentive for the use of innovative and lower-cost technologies.[15]

However, one important effect of the ADCs and the USOF was to redirect some investment away from the more commercial areas towards rural fibre backbone, via BSNL, which is potentially strongly influenced by government or regulator policy. No other developing country has achieved such an outcome through its liberalisation process.

Opportunities

India has an extensive fibre network of BSNL and others, such as railways, electricity and gas networks, rapidly extending into rural areas. The real challenge for India is to use this network in favour of the poor majority who inhabit these rural areas. Making this capacity usable ("lighting" it) costs only about 20% of the actual cost of laying the

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6 The current TRAI recommendation is that ADCs should be abolished and any payments made directly from the Universal Service Obligation Fund (USOF).

7 Harsha de Silva "Chapter 10: Access Deficit Tax?", in *ICT Infrastructure in Emerging Asia: Policy and Regulatory Roadblocks* eds. Rohan Samarajiva and Ayesha Zainudeen (New Delhi: LIRNEasia/IDRC/SAGE Publications, 2008), 160 www.idrc.ca/openebooks/378-2

8 Williams *Broadband for Africa*, 17

9 More precisely, 5% of the adjusted gross revenue of all operators except pure value-added services such as internet service providers (ISPs).

10 Malaysia tops the world with a 6% levy.

11 Payal Malik "Chapter 9: Universal Service Obligations: To Incumbents", in *ICT Infrastructure in Emerging Asia: Policy and Regulatory Roadblocks* eds. Rohan Samarajiva and Ayesha Zainudeen (New Delhi: LIRNEasia/IDRC/SAGE Publications, 2008), 150 www.idrc.ca/openebooks/378-2

12 The USOF also subsidised digital exchange lines installed prior to April 2002.

13 Malik "Universal Service Obligations: To Incumbents"

14 Rohan Samarajiva and Ayesha Zainudeen, eds. *ICT Infrastructure in Emerging Asia: Policy and Regulatory Roadblocks* (New Delhi: LIRNEasia/IDRC/SAGE Publications, 2008), 108 www.idrc.ca/openebooks/378-2

15 De Silva "Access Deficit Tax?"; Malik "Universal Service Obligations: To Incumbents"

network.[16] This would have huge potential for extending the backhaul into every village using low-cost wireless technology for the link.

In addition, TRAI has shown its willingness to learn from and act to correct its mistakes. Even its critics acknowledge that the results of the ADC "would have been much worse if a different organisation, which was less consultative and had less expertise, had tried it."[17]

Fibre backbone in Africa

Over 500,000 kilometres of backbone infrastructure has been rolled out in sub-Saharan Africa, but only about 12% (about 60,000 kilometres) is fibre-optic cable. The remainder is microwave, mostly backbone for mobile phone operators. Most fibre backbone is used for fixed-line backhaul. Very little reaches into rural areas, usually in transit somewhere else, with satellite being far more common. A small number of wholesale backbone suppliers, selling leased lines to companies and bandwidth to other operators, are emerging, such as Kenya Data Networks (KDN) in Kenya, which has a network of over 1,900 kilometres. New operators are teaming up with rail and electricity fibre owners to develop wholesale services, though connecting mainly major urban centres. A few governments such as those in Ghana, Kenya, Ethiopia and Uganda are also investing in fibre backbone. Yet the percentage of the population living within range of fibre is low, even in those countries with more extensive networks. The percentage living close to two fibres – hence in principle potentially benefiting from competition – is even lower.[18]

Fuelling current interest in fibre backbone is the prospect of submarine fibre-optic cables along the eastern coast of Africa connecting a string of countries – there are now four cables vying to be first to land – and a determination not to make the same mistake as the SAT-3 undersea cable linking countries on the west coast of Africa. The latter is controlled by a consortium of incumbent telecommunication operators, each with a monopoly on national bandwidth. Most use it as a way to maintain their dominance of international bandwidth, resulting in high prices and limited usage. The expectation of low-cost international bandwidth has kindled interest in expanding terrestrial fibre into landlocked countries such as Rwanda and Uganda, but also in building out national fibre networks. The question is the extent to which these might reach into rural areas and benefit poor communities. This is something that an open market alone will not achieve and for which public financing of some kind will be needed.[19]

From a pro-poor perspective, one of the most interesting of the proposals put forward was initially associated with the Eastern Africa Submarine Cable System (EASSy), calling for an "open access" structure. Although what precisely comprises "open access" continues to evolve and is only partially being implemented by the EASSy consortium, the basic principles could be applied to rural fibre backbone. These are:

- *Access is open to all:* The network is "plug and play", where any service provider is entitled to ask for and gain access, including those at the periphery of the networks. This means that small and local players can use it to deliver their services.

- *Technology-neutral regulation:* All technologies should be permitted to plug in, as long as they have the appropriate physical attributes. Regulation should encourage innovation in technologies.

[16] Malik "Universal Service Obligations: To Incumbents", 155

[17] De Silva "Access Deficit Tax?", 170

[18] An analysis of Kenya, Mali, Uganda and Nigeria concluded: "The coverage of the incumbent fixed operators' networks is quite limited at only 23% to 33% of the population. It also shows that competition among the fixed operators with fiber networks only benefits the limited proportion of the population that lives within range of more than one fixed fiber network" – i.e., between 8% and 25% of the population (Williams *Broadband for Africa*, 15).

[19] Williams *Broadband for Africa*, 36-7

- *Fair and non-discriminatory access:* No service providers should be discriminated against or given favourable deals. Competition should be encouraged in service areas.

- *Transparency to ensure fair trading:* Tariffs and prices between the backbone and service suppliers should be transparent.

- *Everyone can connect to everyone else:* No providers should be blocked from connecting with others, and bandwidth access from local to international should be readily available.

Pro-poor regulatory components might include preferences for providers in poor communities or subsidised bandwidth. However, these would be fully transparent and in line with universal access policy goals.

Lessons learned

A number of lessons emerge from the Indian and African experience:

1. Extensive fibre-optic backbone into rural areas will most likely not be built by market forces, even where well regulated. Public funding and incentives are needed.

2. In the absence of regulation (or the presence of poor regulation), mobile operators – the most profitable investment in the short term and hence the main growth area – will tend to build their own proprietary backbone networks, limited to their individual needs and unavailable to others. However, their own long-term interests, as well as those of others, will be served though the economic efficiencies of aggregating bandwidth on shared fibre backbone.

3. The level of profitability of the telecommunication sector, especially of the mobile telephony operators, is typically sufficient to yield a surplus that can contribute significantly to building rural fibre backbone. In India, the combination of both ADCs and a 5% contribution to the USOF during a period of intense growth yielded exceptionally high reallocations.

4. The successful deployment of mechanisms by the regulator, whether using ADCs, UAFs/USOFs or other means, requires significant capacity, tenacity and independence in the context of a powerful incumbent and/or a reluctant government.

5. In the absence of significant fibre backbone to which regulatory obligations can effectively be applied, strong consideration should be given to a vehicle such as a Special Purpose Vehicle (SPV),[20] following principles of open access.

None of the above, however, guarantees a pro-poor orientation to rural fibre backbone. Rather, they might set in place preconditions, and certain favourable dispositions, by ensuring that the rural fibre backbone is subject to influence by policy and regulatory actors who might bring with them a pro-poor orientation. Few examples of a specific pro-poor approach to developing backbone can be found in the developing world, perhaps because the pressing issue is to first extend fibre into rural areas. Nevertheless, a pro-poor approach should be planned into the process at as early a stage as possible.

References

[20] An SPV is a corporate vehicle (usually a company) created to fulfil narrow, specific or temporary objectives, usually to deal with financial risk, and in this case comprising a partnership of public and private entities.

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