Why is Connectivity in Developing Regions Expensive: Policy Challenges more than Technical Limitations?

Rahul Tongia
Carnegie Mellon University (CMU), School of Computer Science (ISRI)
Pittsburgh, PA 15213 USA
+1-412-268-5619
tongia@cmu.edu

ABSTRACT

I present analysis examining some of the causes of poor connectivity in developing countries. Based on a techno-economic analysis and design, I show that technical limitations per se are not the bottleneck for widespread connectivity; rather, design, policy, and regulatory challenges dominate.

Categories and Subject Descriptors

C.2.1 [**Computer-Communication Networks**]: Network Architecture and Design – *network communications, network topology, wireless communication.*

General Terms: Management, Design, Economics.

Keywords

Digital Divide, Broadband, Internet and Telecom Access, Wireless, Optical Fibers, Techno-economics, Open Access, Africa

1. INTRODUCTION – DIGITAL DIVIDE

Mobile phones are often thought of as the bridge across the digital divide. However, they cannot easily provide broadband connectivity, especially not at low cost (claims of 3G wireless notwithstanding).

What the digital divide is depends on whom you ask. Is it the ability to make a phone call? Get on the Internet? Through personal means (e.g., in-home) or in a shared (kiosk) mode, and if the latter, how close by? Unfortunately, almost all studies on the digital divide suffer from methodological flaws, especially related to granularity. E.g., [1] finds correlations between incomes and penetration, or [2] between competition and penetration. While indicative in terms of overall trends, specifics should not be drawn from these because national data, suspect or outdated in many cases, never apply across wide population segments. Average incomes are based heavily on a small population subset, often in the capital. Similarly, while there may be 2 or 3 mobile providers, they may not all have footprints in the same areas, especially rural areas. A bottom-up analysis of components of costs, presented here, can show what factors matter when considering costs.

2. ACCESS TECHNOLOGIES

2.1 Developing Region Issues

Digital divide statistics abound, and show most ICT usage is in developed countries. Even in more advanced developing countries, such as China, the growth has been asymmetric. Focusing on Africa, we find teledensity as low as 5.3 per 100 population in 2002 (fixed plus mobile), growing to over 11 by 2005-end, mainly from mobiles. Investments are large, estimated around $30 billion between 1995-2002 [2].[1] But, if mobiles are successful, what about the Internet?

Studies have shown that the majority (~70%) of ICT differentials can be shown by income levels, with additional variation explained by urbanization, regulatory regime, literacy, and age [2]. Thus, costs of access to the Internet matter. The ITU"s Digital Access Index is one composite metric that factors in affordability when comparing ICT (in addition to quality, infrastructure, and knowledge). However, it only studies basic (20 hours) dial-up, and uses average numbers across nations.

2.2 Broadband techno-economic framework

Tongia [3] presents a generalized model for analyzing broadband connectivity, which includes stochastic or parametric elements for many of the variables. The four major components of the monthly costs are, [with subcomponents/factors that matter in brackets]:

1) *Capital expenditure* (amortized into monthly payments) [turnover or churn rate, interest rate, financing period (which is linked to churn and market competitiveness)]
2) *Operating Expenses* [customer relations, billing, maintenance]
3) *Uplinking costs* [transit or backbone fees, rated or advertised speeds, oversubscription ratio, applications allowed (e.g., peer-to-peer, voice, etc.) and topology (where does contention and sharing occur)?]
4) *One-time costs* [installation, activation, customer premises equipment (if bundled with service, else is a capital or subscriber cost), marketing, rights of way charges or spectrum, as applicable].

Importantly, this model focuses only on costs, and not price. Retail prices often have very little to do with costs, for various market, competitive, and social reasons.

Under the generalized framework as above, how does one reduce the digital divide? The first step is determining which services (and thus, technologies) apply. Availability of existing infrastructure is vital to low costs. Cable modems and DSL utilize copper that was laid to carry other, revenue-bearing services. The success of mobiles across Africa (landlines are only ~3 per 100 people, mainly in urban areas [4]). limits migration paths for broadband.

[1] Only a fraction of investments went into new infrastructure; the remainder went into buying existing stakes through privatization, or licensing/regulatory fees.

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Table 1: Indicative Broadband access technologies and costs for consumers (residential) (US$)

	Typical speeds (mbps) [Down/up]	First hop ends	Capital expenditure/ subscriber excluding CPE	Customer premises equipment (CPE) Costs	Operating costs per subscriber/ month	Uplinking costs /subscriber /month	One-time costs	Typical prices seen in developed countries	Typical prices (developing regions)	Tech. Maturity or deployment
DSL	0.64-100 both	Central Office (CO)	40	10	Operating costs are assumed to be comparable across technologies, differentiated more by business model and location than technology. Costs range from 1-6 typically.	Uplinking costs are strongly a function of location and of rated consumer speed, instead of technology. Ranges from 2-10 typically, but higher in some locations.	Low (assuming existing copper)	20-50	5-100 (varies with speeds)	High
Cable	.1-10/lower	Head-end	~100	10			Medium	30-60	5-100	High
Broadband over Powerlines	1-4/lower	Distribution Transformer	~300	20			High	30-40	NA	Low
Fiber to the Home	100/100; lower if shared (PON)	Access cabinet or CO	~1000 (western figure)				Highest	30-70	NA	Low
Satellite	0.64-45/lower	Satellite	~500-1000	300-500			High	70-90	200+	High
3G cellular	0.384-2/lower	Base Station	~300+	~200			High-medium	60+	40+ (limited throughput)	Low
Fixed wireless										
WiFi (mesh) (802.11b example)	1-11 (raw, lower in practice)	Neighboring node	~100	10			Low	20+	??	Medium
WiFi (access point)	1-11	Access point	~100 (no tower)	10			Low	20+	??	High
WiMax/802.16	.5-10	Base station	100-200	250			Medium	30+	??	Low

We see capital expenses are only a fraction of total monthly costs, especially for reasonable costs of capital (10-15% interest rates). Tongia [3] goes through the above exercise in detail for a particular technology (broadband over powerlines).

Given different design options and commercial choices providers can make, comparing technologies and providers is difficult at best, and meaningless in many cases. Once we determine the reasons for the varied (and high) costs, we can determine new designs and policies to reduce the costs of connectivity.

2.2.1 *Policy and Add-on Distortions*

Cost per user clearly depends on chosen technology, penetration level, user distribution, as well as factors outside the broadband domain, including availability of complementary infrastructure. A further distortion in access costs occurs when we consider how policies (especially governmental) lead to artificial increases in the cost of connectivity (or other ICT). If one starts with the equipment (hardware, software, and installation) for an *ideal* network (optimized for user conditions), there is an associated cost to end-users (which we can extrapolate from Table 1). Any policy decisions on top, for whatever reason, create additional costs, distortions, or rents. Below are policies I identify that make connectivity more expensive for the end-user (not in any particular order): ISP licensing fees, Spectrum, Rights of Way charges, Import Duties, User Taxes and Surcharges, Uplinking and interconnection restrictions, Limits on applications and services, Limits on sharing connectivity, Lack of clarity / consistency on “affiliate transactions”, Low density of target users, Design without scalability or upgrading possibilities, Proprietary or National-only standards, High costs of regulatory compliance, Higher failure rates and/or maintenance, High costs of capital.

3. CONCLUSION

New technologies continue to evolve, and this will help push deployment of Internet access across the world. Not only will costs fall, but capabilities will continue to expand, especially in wireless technologies. Even then, the generalized techno-economic model shows that equipment costs are only a fraction of the total costs, and new designs must be considered that integrate innovations in policy and business models. Our work shows that new designs of technology and of business models can to overcome policy distortions, such as through open access networks.

4. REFERENCES

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