Ten Objections to a Comprehensive, High-Speed Internet Backbone in Bangladesh

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Many at the workshop favored the development of a high-speed Internet backbone with points of presence in every village, but others were skeptical of both that goal and the role of the government and multilateral organizations in achieving it.

Their objections and concerns were valid, but these are complex issues, and there are two sides to each point.

I will paraphrase several of the objections I heard, and comment on how they might be met. I also ask several explicit questions which other attendees may be able to answer, and would welcome both constructive and critical feedback.

1. Internet connectivity would be nice, but it is not a high priority. Power, clean water, nutrition, employment, literacy, etc. are more important and should be addressed first.

It is our hope that the Internet infrastructure could lead to improvement in each of these areas. As Kofi Annan recently stated:

> Affordable technologies, in the hands of local communities, can be effective engines of change, both social and material. Access to information and technological know-how is essential if the world is to defeat hunger, protect the environment and achieve the other Millennium Development Goals agreed by Heads of State and Government at the United Nations Millennium Summit in 2000.

This is not to say that the Internet is a "silver bullet" that will turn a village into a developed suburb with a chicken in every pot and a car in every garage, but I believe it can make a marginal difference in many areas. Grameen Telephone operators have not become rich, but they are eating better than they had before and farmers may be able to save a trip to town or know when to catch a bus. The savings may be small, but widespread.

2. BTTB has already connected the 64 district headquarters, and they are planning to connect the 410 upazilas by end of next year. There is little demand for this service.

One attendee tried to subscribe to this service, but the local BTTB representatives were ill informed and unable to assist him. If the service were readily available and adequate customer support available, there might be more customers.

Price also obviously affects demand. I do not know the cost of the existing service, but we did hear that BTTB DSL prices are much greater than in developed nations. What are the BTTB charges? To what extent is the lack of demand in district offices a function of pricing, and how does BTTB determine prices?

The public may not be generally aware of the availability of the existing service. As with price, I have no idea of the scope or appropriateness of the BTTB marketing effort.

Even with points of presence in every upazila, BTTB would not reach the rural population. Professor Choudhury guessed that perhaps 35-40% of the people live in these urban and semi-urban areas.

Cost, support, and availability surely affect demand, but there is a more fundamental factor: the current BTTB offering is *not the service* I have in mind. Dial-up Internet over a slow connection is qualitatively different than high-speed Internet over an "always on" connection.

When I first visited Bangladesh, connection speed and reliability were very low. Even character-oriented Telnet sessions were difficult from ISP locations in Dhaka. The situation was a bit better this time, but, still, browser based email was nearly unusable from the conference site.

I do not know the speed of the BTTB links serving the district headquarters and upazilas, but my guess is that it is quite low, and probably infinitesimal on a per-capita basis.

For the sake of discussion, I am suggesting a point of presence with a at least a two-megabit link in each of the 85,000 villages. That capacity would enable a very different experience than the current BTTB offering. It would enable a modern telecenter, many home users, audio and video data, etc.

3. There are no applications of interest or value to illiterate rural people who do not speak English.

We heard a number of examples of useful, even "magical" application at the workshop. These often involve a literate intermediary who sends email or retrieves information on behalf of the ultimate user. These examples were encouraging, but, granted, anecdotal.

The network I am suggesting would enable many more applications. It would be qualitatively different than the current network. It would be much faster than current networks, and it would be a ubiquitous, end-to-end network.

Greater speed obviously enables different applications. For example, downloading movies and other forms of entertainment would be practical. One could imagine a micro-credit digital village theater providing entertainment and news. Or consider health care. Mr. Yahya of Grameen Telephone spoke to us of a partner prepared to offer telemedicine in villages. What would that partner do tomorrow if high-speed connectivity were available in every village today?

The nature of applications would also change with ubiquity. A network with one user is clearly worthless. Add a second user, and the first user has someone to communicate with. A third user doubles the possibilities for our first node. Every new user is a "content provider." If everyone in the village and region has access to the network, everyone is a potential conversation partner and information contributor.

The Internet was conceived as an end-to-end network. The *only* function of the network is to route packets of information as efficiently as possible from one computer to another. The network is "dumb." It knows nothing about the content of those packets. The network routers do not know if the packets they forward contain healthcare information or Bollywood movies. They do not know if the packets contain text or images or the designations of player positions in a chess game. The computers that run the applications -- the clients and servers -- are at the edge of the network. The application intelligence, and hence the innovation, takes place at the edges of the network. Every user is a potential application inventor and developer.

Mr. Raghy Rao urged workshop attendees to "think and act rural." I am largely incapable of that, but the people at the edges of our ubiquitous network will in fact *be* rural. Applications will be determined and funded locally.

We will be surprised. People find unanticipated applications for the technology. The IEEE 802.11 network standard (WiFi) was developed for local area networks in offices, but, as Dr. Luiz DaSilva showed in his presentation, it has been used to build community networks. It has also been used for point-to-point links and commercial hot spots. It will be used for hut spots. (I stole "hut spot" from Iqbal Quadir of Grameen Telephone).

After the workshop, several of us took a tour to Bangabandhu Bridge. We drove for several hours, and for most of the trip watched rural people drying and threshing rice along the side of the road. The road construction crew

built transportation infrastructure, but the rural population saw it as an extensive horizontal surface, a horizontal "affordance," and used it for their application.

When HiTech City was being built in Hyderabad, I saw modern cranes and women carrying sand on their heads working side by side. Chile was able to export systems for the logging and banking industries because they had developed and refined them for internal use. I have been to many conferences at which I received a plastic notebook, but have never seen woven portfolios like the ones at our workshop.

Rural and urban people will apply the network to their own problems using their resources and knowledge of the problems. Once completed, this network will become a platform for deploying and testing such applications whether they were developed in Bangladesh or elsewhere. It will be a resource for the global development community.

4. There is no business model.

Nearly every speaker was questioned as to the sustainability of their project -- their business model, cash flow, pro forma profit and loss, etc. There was so much reverence for free enterprise that at one point, while drowsy due to jet lag, for just a few seconds I dreamt I was at a meeting of George Bush's Council of Economic Advisors.

The free market has been very kind to the United States, and, as an employee of a State University, I have first hand experience with inefficient, innovation-stifling bureaucracy, but a market is a tool for forming capital and organizing production, not a religion.

We should not be naive in thinking private enterprise will automatically do the "right thing" leading to optimal resource allocation and prosperity. Private companies work to their own advantage, which is often not coincident with that of the nation. Markets and government initiatives have strengths and weaknesses. We should use both, and not embrace either uncritically.

There are many examples of excellent return on government infrastructure investments. For example, in the US we have had regulated monopoly for telephones, rural electrification, many municipal utilities, the Global Positioning System, the Interstate Highway System, etc.

A research and procurement investment of a less than $200 million paved the way for the Internet. The United States National Science Foundation (NSF) had no sustainable business model for their Internet backbone. In fact, its phase-out was planned from the start. While it lost money, it improved the cost-benefit equation for every network that connected to the backbone. A backbone connecting every Bangladeshi village would play a similar role. It would be a common investment that made the network possible and improved the business model of every application in every village.

Governments encourage infrastructure creation in many ways -- by funding research, establishing regulated monopolies, procuring infrastructure, operating the infrastructure, or a combination of these. The projects also change over time. In the case of the Internet, the government financed the research primarily through grants to universities, procured the NSFNet, and contracted for its operation. Once it was well established, they phased out of operation over four years. NSF procurement was restricted to backbone infrastructure and a connecting link for each university. The owners of the connecting networks were responsible for their own funding, staffing, application development, etc. Innovations developed at one location were shared and quickly disseminated through the network.

Note that even in a government-organized project, much of the work is done by private industry. Companies bid on construction of roads, satellite systems, dams, power distribution grids, etc. In the case of the NSFNet AT&T, Sprint, Merit (a university consortium), and others won contracts for the actual work. The same would

be true of a Bangladeshi backbone. Grameen, BTTB, PCBD, and Wi-Lan might build the backbone; the network operations center might be contracted to a university; the military or a private contractor might be responsible for the physical security of towers and cables (with pay as a function of uptime); etc.

5. The project is not sustainable.

Bangladesh and other developing nations have experienced the frustration of seeing study reports gather dust and pilot projects disappear when external funding ran out. In such cases, the beneficiaries of the investments were the people working on the reports and projects, not the nation.

I share this frustration, and am not advocating another isolated quick-impact project. I am advocating several research studies carried out in preparation for and support of a ubiquitous infrastructure project. We would not expect the research to be "sustained" beyond its completion, but it would not be an end in itself.

For example, we heard of the promise of forthcoming IEEE 802.16 wireless equipment. Dr. Roger Marks described fixed line-of-sight, fixed non-line-of-site and mobile versions of the standard each with many tunable parameters. The number of channels devoted to a link, the modulation scheme, antenna "steering," transmit power, etc. can be changed under program control. Some devices will operate in license-free bands; others will be licensed. Dr. Marks expects diverse base station product offerings. Experimentation will be necessary to understand how to select, configure, and tune this equipment for Bangladeshi backbone links.

That experimentation should be informed by a detailed understanding of the Bangladeshi environment. We know that Bangladesh is relatively flat (the highest point is only 1,230 meters) with a lot of vegetation and rain, but we need detailed mapping. Where is the current fiber? Which areas must be covered using wireless technology? What are the populations in those areas? What is the nature of their topology, vegetation and climate? Geographic information systems as described by Mr. Basanta Shrestha may be developed to answer such questions. These may be combined with expertise in antenna design and radiation modeling to refine a backbone plan.

Other research needs to be undertaken. Power alternatives such as those outlined by Ms. Manisa Pipattanasomporn, Dr. Saifur Rahman, and Mr. Tarik-Ul-Islam must be investigated. The current state of the nation's fiber links and the equipment on them must be assessed. A network operations center must be designed. Etc.

Note that these are not large projects. They would require the time of people with expertise in 802.16 implementation, antenna design and radiation modeling, GIS technology and the geography and climate of Bangladesh, power systems, optical networking, and information systems, high-altitude platforms (which may offer advantages during rain), but no large capital investment. Industrial cooperation should also be sought.

This research would not be for the sole benefit of Bangladesh. Bangladesh is typical of many developing nations. There is poverty, illiteracy, little Internet connectivity, few trained technicians and skilled, demanding users, poor power and telephone infrastructure, weak government policy, a strong, conservative incumbent telephone operator, regional differences, etc. Necessity is the mother of invention, and many developing nations have needs similar to those of Bangladesh. As we have seen with micro-credit, the lessons learned in Bangladesh would be valuable to all.

While the research would not be for the sole benefit of Bangladesh, it would lead to implementation that would be of direct benefit. The world community would be both learning from and assisting Bangladesh. In today's global political context, providing assistance to a Moslem-majority nation with universal suffrage and a parliamentary democracy seems like a good idea.

Note finally that the Bangladesh implementation would itself be a pilot study for en eventual global design and implementation.

6. Even if the world community can justify sponsoring the research leading to a concrete backbone plan, Bangladesh cannot afford to implement the network.

That is true. The title of my presentation was "Grand Challenges," and I am thinking of challenges to the world community, not to Bangladesh. How much are we talking about?

A multidisciplinary feasibility study is needed for even a close estimate of the amount, but high-speed connectivity to each of 85,000 villages would be a major project costing hundreds of millions of dollars if not billions. This would indeed be a grand challenge, but it would be of immediate value to Bangladesh and provide experience for the final challenge of global connectivity.

Using the "back of an envelope," we can envision the following costs:

Item	Comment
POP equipment and installation	Router, server, peripherals
POP power	$3,000 estimate
POP building	Best left to local people
POP radio, tower and antenna	Should radios be homogenous?
Backbone radio, tower, antenna	Should radios be homogenous?
Backbone maintenance and security	Private firm?
Optical backbone upgrade	After assessment
Network operation center	Key to maintenance

As was the case with the US NSF Network, the above suggests both backbone expenses and expenses associated with making the connection in the village. With 85,000 villages, the cost of village facilities will swamp the cost of the backbone and network operation center.

The POP equipment in the village includes a router, server and peripherals. This can easily be standardized, and should be designed with performance, maintenance cost and power requirements in mind.

Manisa Pipattanasomporn and Saifur Rahman estimated that the cost of solar power over ten years would be around $3,000. That may be taken as a worst-case estimate since some villages may have reliable power already and others may utilize lower-cost power sources. As with the POP equipment, we should strive for one or a few uniform designs.

The POP building should probably be left outside the scope of the common infrastructure. Availability of facilities will vary from village to village, and construction skills are locally available. Building specifications can be specified.

The radios, towers and antennae really cannot be considered until the backbone architecture is designed. One possibility is to view the fiber backbone as a bus with wireless feeds. That would imply three classes of radio/antenna: those interfacing directly with the fiber bus, those in the villages, and intermediate radios. The intermediate radios should form a mesh for performance and reliability. The backbone interface radios should be able to communicate with their neighbors as well as intermediate radios and nearby village radios. Village radios must communicate with intermediate and backbone interface radios and perhaps each other. To what extent can the three classes of radio be identical and where should they be differentiated?

As Marut Lueprasert told us, humidity, rain, and insects are a hostile environment. An isolated backbone radio tower is also a tempting target for thieves or even sabotage. Provision must be made for maintenance and security. A private contractor or a government agency might do this, and financial incentives could be provided for uptime. There must also be plans for the logistics of spare equipment, training, and a state of the art network operations center to monitor connectivity and performance.

The cost for all of this would be great compared to the scope of the pilot projects we have seen to date, but G8, ITU, UN, World Bank, and others have talked extensively about the human development returns to Internet connectivity investments. Seen from that perspective, it is not an outlandish for a grand challenge.

7. Bangladesh villages cannot afford to use the network even if the backbone transport and connection are free.

Bangladeshi villagers have formed businesses around cell phones, cows, and sewing machines. There is a well-developed micro-credit system and culture. Capital will be formed locally, both to serve existing institutions such as government and the Grameen Bank and for new applications like digital news and entertainment. Applications that are successful in one area (domestic or foreign) will quickly spread. This is the level at which markets will operate.

Still, one should not underestimate the task faced in the village. A village should be required to demonstrate some level of readiness before receiving equipment and being connected to the network. Installation and handover of the network connection must be covered in the equipment cost. In developed nations we speak of "truck rolls" when a technician must visit a home to install a DSL or cable modem. The cost of "cart rolls" will be substantial and should be anticipated.

With so many villages, one should invest considerable effort in the design of POP equipment and software, training, and remote monitoring from the network information center in order to simplify installation and maintenance. The network itself should be used for update distribution and maintenance related communication. Every dollar saved by clever, comprehensive design will save $85,000.

8. Bangladesh does not have the government will and people for this project.

Although the World Economic Forum rates the ICT prioritization of the Bangladesh government as 43rd out of 100 nations, the government was conspicuously absent from our workshop. There was no representative of the ICT Ministry or of key user ministries like health or education. BTTB is a government organization, but, in spite of the good intentions of individual employees, the organization has a conflict of interest.

This is a troubling factor. A government leader or coalition is probably necessary to champion the research project we spoke of earlier (although a university might be able to take the lead). The history of networking in the US might be instructive. The ARPANet and the experiments preceding it were underwritten by a government agency, the Information Processing Techniques Office (IPTO) of the Advanced Research Projects Agency of the Department of Defense.

However, IPTO decisions were not made by government bureaucrats, but by visionary faculty members from universities who were brought in for temporary assignments. Similarly, outstanding people, often on temporary assignment, designed and oversaw the contracting for and operation of the NSFNet.

The ARPA and NSF networks were research projects, not stable government programs. At the time, people were still debating the relative merits of packet and circuit switching and TCP/IP versus OSI. No one had ever built a nationwide internetwork. The design and deployment of a Bangladeshi backbone would also be a research project.

In the US we often bring university and other research people into agencies to guide research and complex development programs. In Singapore government technical positions are prestigious and pay well, so good people take permanent positions. Regardless, a small group of highly qualified people should be responsible for the vision, experimentation and awarding of contracts for the backbone network. It should not be left up to the eventual vendors.

9. Bangladesh cannot afford high-speed connectivity. Low-cost store-and-forward technology is more appropriate technology for a poor, developing nation.

This is a recipe for remaining permanently at the back of the "digital bus," for sustaining third-world status. Leading edge technology is more powerful and economical and easier to use than older technology. Bangladesh and other developing nations should use leading edge technology for appropriate applications.

10. We should focus on cities where there is already demand, not rural areas.

One of the hopes for networking in developing nations is that by bringing education, health care, news, entertainment, contact with the outside, employment, etc. to rural areas, the quality of life may rise to a point where migration to crowded cities will be diminished. That, of course, demands focus on rural areas.

It is relatively easy to reach the rural people in Bangladesh because it is so densely populated. With 925 people per square kilometer, Bangladesh has nearly three times the population density of India. There are 140 million people in an area smaller than Iowa. There may be few developing nations in which the cost of reaching the rural population may be as low per capita as in Bangladesh.

There is also the question of ethics, of a just society providing the greatest good for the greatest number of people. Gandhi spoke of the concept of *antyodaya* in which we focus attention first on the poorest, most needy people. By loaning money principally to landless rural women, Grameen Bank has shown that antyodaya and profit can be compatible.