Rapid Assessment for Internet Access Initiative:

Connecting Liberia

Summary Report: A Path to Action and Results

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Executive Summary

OVERALL FINDINGS

The Government of Liberia (GoL) has initiated an ambitious program of poverty reduction and rebuilding of the national economy and institutions after a long and devastating conflict. Together with the people of Liberia and the nation's partners in the donor community, much is being done to accelerate the development of Liberia. Hampering the peace dividend is a very expensive and inefficient infrastructure for providing Internet access, which is preventing it from fulfilling the government's desire to employ information and communication technologies (ICT) as one of its tools to support development. This report is the result of a quick assessment performed at the request of USAID/Liberia of the potential for effecting changes in the national Internet system that would permit it to be used more effectively.

The basic findings of the report are that:

- Internet access in Liberia today has limited coverage, poor performance, and high prices.
- This situation results from both local and continent wide factors -- Liberia faces the same problems as other African nations (limited and expensive connection to the global Internet backbone and limited penetration of telecommunications services in rural areas), but also faces its own unique issues (destruction of the nation's power and communications grids and a thin local market due to economic stresses).
- Fortunately, technological developments in Internet hardware now permit some major improvements in the cost and performance of Internet access, if Liberia chooses to adopt them. Affordable wireless systems are now available for the "last mile" connection to the customer.
- Connection to the global Internet backbone may soon be accomplished by sending the nation's Internet traffic via cost effective and rapid undersea fiber-optic cable and/or over land by microwave or fiber-optic cable instead of the present expensive, slower and bandwidth restrictive satellite links.
- The Government of Liberia has put in place a few key building blocks for a strong telecommunications legal and regulatory environment, including the Telecommunications Act of 2007, and draft ICT Policy, and the harmonization of the licenses for the country's four cell phone service providers.
- Significant improvements in availability, cost, and performance can be achieved if the Government of Liberia undertakes a package of improvements in infrastructure, regulation, and systematic utilization. USAID could provide important technical and financial assistance to help achieve these goals.

TECHNOLOGICAL CHANGES

Defining the contents of a "package" of investment and reform in the Internet sector is a complex, multi-stakeholder process, some of which will depend on a more detailed technical and financial analysis of specific technical options. A desirable set of infrastructure reforms would include changes to the "**last mile**" connection to the consumer, to the "**distribution**

networks" that carry Internet traffic within Liberia, and to the "**gateway**" to the global Internet backbone. Based on this study's quick assessment, the set of reforms include the following:

- Provide the "**last mile**" access by consumers, using terrestrial wireless WiMAX, WiFi, or cell phone data protocols rather than expensive satellite links;
- Utilize of the nation's only "**distribution network**" – cell phone towers -- to move Internet traffic around the country; and,
- Facilitate the accomplish the "**gateway**" to the global Internet backbone via fiber-optic networks (probably submarine cables) that are now emerging to serve Africa, either by high-bandwidth cross-border connections or by attaching directly to the submarine cable from Liberia.

These three technologies work together as system; a bottleneck in any part will prevent any improvement in the performance of the whole system. Currently, there are bottlenecks in all three elements. Thus, fixing the technical performance of Liberia's Internet infrastructure will require a coordinated reform on all three fronts.

INSTITUTIONAL CHANGES

The present state of the "Internet sector" institutions providing Internet connectivity is fragmented and inefficient, and forced by the lack of power and communications grids to rely heavily on individual satellite links for each customer. National policies concerning Internet, the regulations to guide the implementation of that policy and the ability of the telecommunications regulatory agency effectively to enforce those regulations are all at a nascent state. Undertaking a significant reform of the Internet sector will imply substantial changes for all the involved institutions. In order to manage a transition to a more appropriate national structure for Internet provision, attention will need to be paid in the following areas:

- The government is well along the path of defining national policy at a general level with a draft ICT Policy. Rapid change in the Internet sector will require continuing attention to the development of more specific policies related to those changes. Technical assistance from USAID or other donors will be important for the timely development of these new policies.
- As long as the private sector has the wherewithal and there is an enabling policy environment, technology investment is best left to the private sector, using its own resources. In order for this to occur in a productive and efficient investment, it will require a supportive regulatory context to ensure that equity and competition are maintained. The demands on the regulatory agency for quick formulation of, and transparent enforcement of, new regulations and processes will be substantial. A very significant level of technical assistance from USAID or other donors will be crucial.
- The cell phone providers' network of cell towers is now and will probably remain the only communications infrastructure with national coverage. The licensed providers are already sharing these towers to reduce their costs. Ensuring equitable and affordable access to Internet throughout the country will be extremely difficult without involving this national asset. Regulation to ensure fee-for-service co-location will be critical for this process to happen in a way that is fair to existing and new providers of access, and serves the needs of the people of Liberia.

UTILIZATION CHANGES

The purpose of improving Internet access is to accelerate the economic and social development and improve the quality of life for the population of Liberia. For these reasons, the GoL – with the assistance of donors – is making investments in public institutions to have the Internet. It is worth making a systematic effort to ensure that maximum possible advantage is gained from these substantial investments to improve the Internet infrastructure itself. This suggests a need for several actions within the development community:

- USAID should review its own portfolio in anticipation of the availability of rural broadband service, identify ways in which the goals of its programs could be served by taking advantage of the Internet, and incorporate them into program activity.
- There should be a focus on capacity development within the government to understand and take advantage of the new capabilities. At a minimum, technical assistance to analyze and plan for incorporating Internet use into the delivery of government services will be necessary. The government will need to undertake training in the management of Internet systems, computer security, network management, and in some cases even training for basic computer literacy.
- In order to ensure that local NGOs, donor funded projects, entrepreneurs and individuals utilize broadband Internet as an enabling tool for social and economic change, it is important to ensure that information about content and application tools are available across all sectors. Hence USAID should plan to promote information sharing and creation of a national community of interest to encourage and assist other groups to integrate technology use in their activities.

RECOMMENDATIONS

This is a timely moment to undertake a significant activity in improving Liberia's Internet access. The necessary preconditions exist: there is a strong perception of the need for Internet and communication; the GoL is developing the leadership to embrace ICT to support its poverty reduction strategy; new technologies are available that can substantially improve performance and decrease costs; and a great deal is known from experience in other countries about how to apply these capabilities in productive ways. The study suggests three "strategies" that USAID might follow if the Government of Liberia wants to move forward in this arena. The strategies reflect assumptions about three different levels of intensity that the government might adopt, and outline representative activities that should be undertaken. The following table gives a high-level overview of the three suggested strategies.

CHARACTERIZATION OF THE DIFFERENT STRATEGIES			
	Strategy One	**Strategy Two**	**Strategy Three**
General Approach	• GoL sets ambitious goals for improving structure, performance, and pricing of Internet infrastructure • USAID provides energetic support to GoL efforts • USAID provides information and coordination support to development community • Promotion of appropriate developmental use of ICT throughout Liberia • Capacity development concerns addressed	• GoL sets more modest goals for changes to Internet infrastructure • USAID provides structured program of support to GoL goals • USAID is systematic in the use of ICT within its own portfolio • Attention is paid to issues of capacity development • USAID plays informational support role to development community	• GoL does not prioritize reform of Internet infrastructure • USAID provides policy and consulting support on an as-requested basis • USAID utilizes ICT where available and appropriate • GoL and commercial capacity development in ICT not prioritized
Infrastructure Objectives	• Last mile: coordinate demand pull to achieve a large scale platform such as WiMAX is in place • Distribution network: use the cell phone towers for carriage of data and encourage cooperation among cell carriers • International gateway: accomplish shift to cable landing site or cross-border connection to submarine cable	• Last mile: work with cell phone companies to assure widespread availability of cellular data protocols • Distribution network: data backhaul over cell towers • International gateway: support analysis of options; assume slower progress toward solution	• Last mile: use cell phone data protocols when and where available; otherwise no change • Distribution network: no special focus • International gateway: resignation to current situation
Support of GoL& USAID Efforts	• Structured program of active support to GoL efforts • Resident advisors for technology, policy, and applications • Active training programs for regulatory and ICT specialists in government	• Structured, less intensive program • Single resident advisor to provide advice, coordinate consulting assistance • Training for regulatory agency	• Consulting support if GoL requests it • Training for regulatory agency
Applications	• USAID incorporates expanded use of improved ICT capability within own portfolio • USAID helps GoL design ICT adoption into government programs	• USAID systematically uses improved ICT where available • USAID provides advice GoL on adoption of ICT	• USAID portfolio continues on current path • No special focus on GoL adoption of ICT
Timeline	• Training and support elements begin immediately; infrastructure elements take approximately 18 months before biggest improvements arrive	• Training and support elements begin immediately; modest infrastructure improvements disseminate gradually during first year	• Training and support elements begin immediately; little infrastructure improvement expected

It is recommended that USAID move forward in consultations with the Government of Liberia to determine their priorities and their preferences for specific technical solutions. The ideal outcome of such discussions would be a decision to move forward with a major Internet sector reform similar to that described in Strategy One. An adjusted strategy can be developed from the results of those conversations.

1 Introduction

The USAID Mission in Monrovia supports a major program in Liberia to assist the Government of Liberia (GoL) in rebuilding its infrastructure and institutions after a long and very damaging civil war. The GoL has acted decisively to assess and address their problems, and is currently implementing a nationwide Poverty Reduction Strategy. The GoL is implementing a Poverty Reduction Strategy, for which the Ministry of Planning and Economic Affairs (MPEA) is responsible for monitoring progress. Many GoL ministries and donor activities are contributing to this complex effort. The experience of the GoL, USAID/Liberia, and other donors, has underscored the debilitating limitations imposed on reconstruction and development by the lack of an effective communication or Internet infrastructure.

The Government of Liberia has undertaken ambitious efforts in order to achieve improvements in the telecommunications and Internet connectivity areas. They passed and are implementing the Telecommunications Law of 2007. They have articulated and are about to finalize a national Information and Communications Technology (ICT) Strategy, which takes a very positive stance towards using ICT across all sectors to support the achievement of the Poverty Reduction Strategy. They are working on defining and strengthening the role of the regulatory agency in supervising and supporting transparency in the telecommunications sector.

As a part of USAID/Liberia's response to the shared recognition of the importance of ICT, the Mission requested a visit by technical representatives from USAID/Washington and the Academy for Educational Development (AED). During the months of April and May, 2009, a team consisting of Judy Payne USAID Africa ICT Advisor (USAID/EGAT/I&E/ICT,jpayne@usaid.gov), and Dennis Foote (dfoote@aed.org) and Sergio Ramirez (sramirez@aed.org) from AED, visited the country to assess the situation surrounding Internet services and investigate what could be done to improve them. This document is the report of that visit.

1.1 Approach

The approach taken by this team is grounded in several important assumptions:

- that connectivity, communication, and information access are basic needs for development;
- that experience elsewhere in the world has shown that information technology and connectivity have taken hold quickly and provided real benefits;
- that is a realistic and feasible task to achieve substantial improvements in Liberia's access to Internet; and
- that it is not an "either/or" choice between investing in connectivity and investing in other crucial needs, but a "both/and" situation in which parallel, concurrent investments are necessary.

The challenge here is how to fashion a program in which efforts by USAID/Liberia can help the Government of Liberia achieve an affordable Internet infrastructure by organizing the demand for Internet services in such a way that the private sector responds by securing private capital to build an efficient system.

While the expectation is that the private sector will be the source of funding for most of the investments, there will be necessary ancillary investments for the GoL, USAID/Liberia, and other donors in doing the kinds of things that these agencies normally do, such as:

- in institutional development for such functions as policymaking and regulatory enforcement;
- in supporting the creation of training programs to create the necessary human capital in the public and private sectors; and
- in organizing the activities of the programmatic portfolio to take maximum advantage of the potential of the new technology.

2 Assessment Of The Problem

The GoL and USAID/Liberia share a common perspective about the importance of Internet connectivity for the development of Liberia. They invited our assessment team to investigate possible ways to extend affordable access to telecommunication and Internet services in support of development.

Our quick assessment of the organizational and technical factors in the Internet environment confirmed that many opportunities for improvement existed. In order to evaluate the possible paths for moving forward, it is necessary to understand the shortcomings that people are experiencing with Internet, both on the operational and technical sides. The next two sections provide a brief description of the operational and technical factors influencing Internet availability in Liberia.

It should be noted that most of these problems are not really anyone's fault -- they are largely the consequence of the way Internet has evolved in Liberia and the impact of the destruction of the electrical power and communication grids during the war years. By and large, the problems are similar in nature to those in other African countries, although they tend to be more severe because Liberia has had less time in the postwar era to address them.

2.1 What’s Wrong With Internet Access In Liberia?

An informal survey of operational factors conducted during our trip revealed a situation more problematic than in many other neighboring countries. There were major problems in both price and performance of Internet connectivity.

2.1.1 Price

The prices being charged by an informal sample of providers ranged from high to very high, both when judged against the standard of world prices and against the prices of other African countries in the same economic category. Depending in large part on the technology used to provide the service, prices for rural service ranged from the low hundreds of dollars per month to the high single-digit thousands of dollars per month for connections at the 512 Kbps or 256 Kbps levels. In general, these prices were five or 10 times the world prices for similar bandwidth, and sometimes twice or three times the prices seen for comparable service in many other African countries.

Some possible explanations for this situation include:

- Some significant proportion of the high pricing can be attributed to the lack of terrestrial wireline telecommunications infrastructure and the lack of a national electrical grid, which drive the providers to utilize satellite connections that are both intrinsically inefficient and provide no economies of scale.
- Operational costs are high in Liberia. One cell phone company, for instance, reported that it had two guards stationed at every cell tower 24 hours a day to protect the diesel and generators required to provide power for operations in the absence of a national electrical grid.
- The peculiar dynamics of the market in Liberia, in which most of the very few customers who can afford Internet service are donors or donor-funded projects, mean that the market will bear a very high price and few "normal" customers are lost by setting the actual price at those very high levels.

2.1.2 Performance

Most customers do not get the level of connectivity they are paying for. We tested the levels of throughput in many places, using simple free tools available on the web. The results were dismayingly consistent -- a typical finding in places that were paying for 256 Kbps was a throughput level hovering around 20 Kbps. There are many factors that can contribute to such low throughput:

- Reliance on satellite links introduces delays (latencies) that results in many requests "timing out" and needing to be repeated. Trace route testing revealed a very high frequency of these timeouts.
- Considerable congestion was evident in the Liberian end of the transmissions, which suggests that local providers are "overselling" their capacity. Providers typically calculate a ratio based on the usage patterns of their customers that guides them to buy a certain amount of bandwidth on the global Internet to accommodate the communications from their customer base. For example, a provider might buy 256 Kbps of connection to the Internet backbone for each ten customers to whom they sell that level of service, based on their experience with the actual traffic generated by similar customers. If the providers buy too little capacity for the number of accounts they sell to customers, serious congestion results, slowing down everyone's service.
- Throughput was generally better in the wee hours of the morning but seldom achieved more than half of the rated level of service. This supports the hypothesis of "overselling", but also indicates problems at the international gateway level.
- Anecdotal reports by the subscribers of different service providers were uniformly critical; no provider was pointed out as providing an alternative to these levels of performance.
- Taking into account the actual performance of the links -- roughly 1/10 of the nominal bandwidth -- the true pricing in Liberia compared to world prices is even higher than it appears.

2.2 Criteria By Which To Judge Alternative Approaches

There are both technical and operational criteria by which one might judge the attractiveness of potential solutions to the problems of Internet in Liberia.

2.2.1 Technical Criteria

As a practical matter, we can define at least three levels of bandwidth that have practical implications for users. We can think of these as supporting full Internet for groups of users, full Internet for single users, and messaging. In this context, "full Internet" means accessing the full range of content on ordinary webpages, including short video clips and audio content, including voice over Internet protocol (VOIP). The bandwidths mentioned below refer to "true throughput" of the connection, not a nominal figure that is seldom achieved in real life.

- **Full Internet for groups of users**: Liberia, like most developing countries, is not likely to have a high level of private ownership of computers in the foreseeable future. This implies that most Internet access will be gained at places where multiple machines are grouped together to serve a large number of users. Prime examples of this are computer labs in schools, Internet cafés that serve the general public, or computer networks in businesses or government offices. For this level of use, we should plan for a minimum of 1 Mbps. As recently as a few years ago connections of 256 or 512 Kbps were considered adequate for this type of service. However, the "media richness" of webpages and content continues to grow very quickly, and the only realistic target for long-term planning is the higher value. It is worth noting that typical connections for single residential accounts in industrialized countries are now typically 3 to 6 Mbps, in large part because providers expect soon to be delivering streaming video content to these users.
- **Full Internet for single users:** In those cases where an Internet connection serves a single user, such as a privately owned computer or a single "kiosk" computer in a public place, a satisfactory experience can be had at much lower levels. In the past, so-called "ISDN" levels of 128 Kbps have been considered adequate, but in planning a system to serve in the coming decade, it is more realistic to set the absolute minimum at 256 Kbps.
- **Messaging:** For connectivity that does not require access to webpages or streaming content, such as simple e-mail, instant messaging, or cell phone texting, even lower levels will suffice. One might think of this as a "Blackberry" level of connectivity. Because this content typically implies that a character-based message is composed on a device and then sent, the speed of the transmission is relatively unimportant. Obviously, this kind of access does not provide the benefits for information seeking that access to the web provides, but it can still offer useful capabilities for the management of development projects. This type of connectivity differs from "Internet connectivity" in that it can easily be delivered over cell phone data channels, if the cell phone infrastructure is expanded to accommodate this type of service.

2.2.2 Operational Criteria

The operational criteria that would indicate success are more diverse and difficult to specify, but there are at least three criteria that we would like to see met:

- **Financially sustainable**: Any system implemented to improve the Internet environment in Liberia should eventually be able to sustain itself from revenues generated by selling

the service. This does not rule out an initial period of investment or subsidy, nor does it rule out the possibility of an institution like a "Universal Service Fund" that devotes a portion of the revenues from selling the service to ensure that all members of society have the opportunity to participate in access to the Internet.

- **Competition**: In an ideal world, services would be delivered in a competitive environment where multiple providers of similar service vie for the customers' business. In the near term in Liberia, it is probably not advisable to have multiple providers building redundant networks in the same locations, so this criterion may remain an ideal to aspire to in the future. The means of building in competition from the beginning would probably require such radical changes in regulation and infrastructure ownership that it would work against the feasibility of implementing an improved system in the near term. For instance, one could nationalize cell towers, or require the owners of towers to permit co-location of competitors' equipment on their towers. While this could theoretically permit competition from day one, it would likely provoke so much resistance as to thwart the very change we are seeking to implement. Still, competition should remain an objective to be achieved as soon as possible.
- **Strong and transparent regulation**: In order for a new system to serve Liberia's needs, it needs to evolve in a context where the requirements and rules are clearer and transparently but firmly enforced by a strong regulatory body. This will be particularly true in a context where competition does not yet prevail, and where the public good of ensuring access by all may conflict with commercial desires to serve only the densest, most lucrative environments. The Government of Liberia will need to maintain a strong stance toward maintaining a level playing field for the providers of service.

3 What Can (And Can’t) Be Changed To Improve The Situation

At one level, Liberia's current situation of almost complete lack of infrastructure offers them the freedom to plot a new path without concern for sunk investments in the old systems. Unfortunately, the parallels in the area of institutional or human capital do not have a countervailing benefit. The lack of a well-established regulatory body, of experienced and well capitalized service providers, and of a large talent pool of technically trained personnel remain as serious challenges.

These issues notwithstanding, the present situation in Liberia and the state of play in the technical environment represent a real period of opportunity for Liberia. Decisive, energetic intervention at this point can establish the momentum toward appropriate structures and investment that will provide a real near-term gain and will set the course required for continuing long-term gains.

This section provides a brief description of the technical components of Internet delivery in Liberia; it provides a conceptual view of the roles played by different technologies now in use, the ways they tend to limit performance of the overall system, and options that might be available for improving the situation.

3.1 Key Technical Components

For the sake of simplicity, we will divide the relevant technologies through which Internet traffic moves into three segments:

- the "**last mile connections**" through which a customer sends the Internet traffic from his site to the ISP;
- the "**distribution networks**" which carry that traffic through the telecommunications system to the point where it exits the country to connect to the global Internet backbone; and
- the "**gateway**" services that take the traffic out of the country and connect to the global backbone.

Obviously, this same pathway works in reverse to return the reply from the Internet to the original customer. In discussing these segments the pathway, we will describe both the current situation in Liberia, and the optimal end point of a transition to a new level of service.

The function of each segment of this pathway can be accomplished through many different technologies. In principle, the technology, and the performance of each segment, are independent of that used in the other segments. While the segments are independent, the performance of the three segments together can never be higher than the worst-performing segment Solving the problems in one segment does not mean that the overall system will work well; each segment represents a bottleneck that limits the performance of the rest of the system. Only when each independent segment is performing well will the entire system perform well.

3.1.1 Last Mile Connections

The "last mile" link, the connection between the user and the distribution network, is the source of some of the most severe problems in the system in Liberia. Because of the lack of any consistent telecommunications infrastructure, a variety of less than optimal technologies are in use. The desired endpoint is for a consistent infrastructure of “data-appropriate” technology to be used. The ideal solution for this at the level of “full Internet for groups of users” is WiMAX from cell towers to the customers. A less attractive solution that would serve best for “full Internet for individual users” could be based on either of two alternative technologies: point-to-point microwave from the cell tower to a community, with an intra-community WiFi redistribution network; or cellular data protocols utilized for fixed service. While both technologies work, WiMAX allows for a more, long-term solution than WiFi.

3.1.1.1 PRESENT SITUATION

A large proportion of the subscriber connections use very small aperture terminal (VSAT terminals) to connect to the Internet service provider. This is done in one of two ways -- either “one hop” or “two hops”:

- In one hop satellite links, the traffic goes directly to a receiving station connected to the global Internet in some foreign country (thereby combining all the functions of last mile, distribution, and gateway),
- In two hop satellite links, the traffic goes first to a satellite receiving station in Liberia where the traffic of lots of users is aggregated and makes a second satellite hop out to a foreign receiving station.
- All geostationary satellite links are slow -- each round trip up to the satellite and back down requires approximately a half a second -- an eternity in computer time. This massively increases the risk that some computer along the way will give up on waiting

for a transmission, causing a "time-out". This results in a retransmission of the message which adds to traffic volume and congestion. Thus, the first version, single hop, is technically undesirable for Internet connections, and the second version, double, is extremely undesirable.

- In addition to their technical problems, satellite connections also have unattractive price implications. Satellite bandwidth is a scarce commodity and is priced accordingly; there are no economies of scale on satellite bandwidth.

Until the recent expansion of the terrestrial cellular telephone system, there were few options for connecting rural sites -- the satellite was the only way to get your signal back to the communication. Within the last few years however, the penetration of cell phone service has expanded with dramatic speed. This has led to the introduction of another technological option, the use of cellular data services.

- By adding digital cellular radios to their cell phone towers, cell companies can receive data signals from their subscribers through telephones or wireless modems, and use the cell system to move the traffic around.
- The active cell phone carriers in Liberia use the GSM protocols, which means that they *can*, if they choose to, use the cellular data protocols for GPRS and EDGE to offer Internet services. Nationally owned LibTelCo intends to offer cellular service using the CDMA protocols and thus could offer a cellular data protocol called EVDO, which is fundamentally similar to the GSM protocols.
- The cellular data protocols are adequate for the individual user level of connectivity, provided that they are performing at full potential and there are not many simultaneous users within any given cell tower's radius, but they are not appropriate for school computer labs or Internet cafes.
- Presently, EDGE services are offered in a few places. Current users reported similar performance deficits to those reported by satellite customers, which may indicate that at least part of the problem stems from the distribution and gateway parts of the system.

A few entrepreneurs in Monrovia are offering wireless connectivity through point-to-point microwave or omni-directional microwave technologies such as WiFi. These can be appropriate in certain specific situations, but are generally not a good basis for providing service on a large scale.

- WiFi is intentionally designed to have a very small radius for reception, and can become extremely complex if one tries to implement it as a distribution alternative. It is quite appropriate for local redistribution of access within small areas.
- Point-to-point microwave is an effective technology but is inefficient for serving a large number of users because frequency coordination to prevent interference and the cost of new hardware to serve each new customer rules out any economies of scale.

3.1.1.2 DESIRED OPTION

The most appropriate technology for Liberia to adopt for its last mile Internet links appears to be WiMAX, a digital packet radio system that is designed for high-traffic fixed service to many customers, but which has many similarities to cell phone radios in its implementation.

- WiMAX data radios can be hung on cell phone towers and can cover a large area around each tower. Thus, one can capitalize on existing towers and power supplies if the organizational and regulatory factors support it.
- WiMAX digital radios that are hung on cell towers are comparable in price to a cellular data protocol radios, but provide a much better platform for Internet, because they offer full Internet for groups and can handle much larger levels of demand.
- Thus, even if demand levels do not presently require WiMax and could be met by cellular data, it is probably wiser to install the WiMAX now than to build a cellular data network and later have to replace it with WiMAX to meet the growing levels of demand.
- WiMAX consumer equipment has recently entered mass production, and inexpensive. For example, Intel Centrino chips that provide WiFi connections in laptops now offer WiMAX as an upgrade from their 5300 WiFi chip to the 5350 WiFi/WiMAX chip at an incremental price of approximately $34 at retail. Stand-alone modems for WiMAX are available from several suppliers for costs in the roughly $100 range.
- A single WiMAX radio transmitting omni-directionally can provide Internet services in an area in excess of 100 mi.^{2}, which allows the services to be very reasonably priced and still deliver commercial providers an adequate profit margin. This makes it especially appropriate in rural areas, where the density of customers may not be high in any given location.

The synergies between WiMAX service and the infrastructure for cellular telephone systems raise the question of how the service itself would be organized. In countries in which cell towers are treated as a national resource and made available to any vendor who wants to rent space on the tower, it is possible for vendors other than cell phone companies to enter into fair competition and offer the service as their only offering. In countries in which the cell phone providers assert proprietary rights to the towers they have constructed, it may be difficult for an independent ISP to compete directly with the cell provider for provision of WiMAX services. This is an issue that will have to be considered in Liberia and addressed through telecommunications policy reform.

If it is not possible to resolve the WiMAX licensing and business model issues in Liberia, the cellular data protocols of EDGE, EVDO, or the future service levels called HSPA and LTE could provide a limited level of rural service – inadequate for schools or networks, but adequate for individual users and e-mail – provided that the cellular companies can operate them at their rated performance levels.

3.1.2 Distribution Networks

Normally, one would find traffic being carried back from the last mile to the Internet gateway by several different technologies -- microwave relay, fiber-optic cable, and terrestrial wireline. However during Liberia's war, the terrestrial wireline telephone system was physically dismantled, stripped of its copper wire, and left in ruins. Ironically, Liberia's lack of a legacy telephone system may allow it to move directly to a more modern system.

Presently, the rapid growth of cell phone penetration provides the only infrastructure that is available in most of the country. The network of towers typically uses microwave relay to carry telephone calls back to their destination. This is an appropriate and adequate technology for the levels of traffic now being experienced. As the traffic grows, cell phone companies will have to

expand their network of towers and microwave relay systems to avoid congestion or insufficient circuits. In time, it is likely that the cell phone companies will begin to lay fiber-optic cable to handle the increased volume, and this would be an ideal technology for distribution networks. Provided that the cell phone companies rate of expansion of their network keeps up with the growth of traffic, the distribution system should not present a problem to the desired levels of Internet service.

3.1.2.1 PRESENT SITUATION

With the arrival of peace, cell phone entrepreneurs began efforts to establish national systems of interconnected cell towers. The rapid growth of their customer base underscores the high level of demand for communication and connectivity, including (and perhaps particularly) in rural areas. The fact that the cell phone companies operate the only communication infrastructure available probably makes their involvement unavoidable, but raises a number of issues:

- The cellular companies' microwave backhaul system presently functions fairly well, although it will need continuous expansion as the growth in traffic levels continues.
- If data traffic is to be carried by the cell phone system, it may require the use of separate parallel microwave relays, as the differences in the nature of data and voice traffic have the potential for mutual interference if they are carried on the same channel. This would require that additional hardware be hung on the towers, but is not fundamentally different from the current technology. In the case of WiMAX, the WiMAX radios themselves can be configured to serve as the relay system for moving the data.
- At present, there is no existing infrastructure aside from the cell phone system that has sufficient coverage in the rural areas to provide a helpful solution for Internet connectivity. To provide national coverage, the penetration of cell phone networks into rural areas would have to continue to expand.
- The regulatory issues pertaining to competition and a level playing field for all providers also apply the distribution networks. Complex regulatory determinations about open access to the towers and the organizational structure for commercial provision of service will have to be made. The Government of Liberia will need to determine if and how other entities might also be involved in delivering Internet service.

3.1.2.2 DESIRED OPTION

The desired features of a distribution network are that it should be technically efficient and delivered in a way that results in competition and fair pricing. The logic of using the cell phone tower network at least as a physical basis for microwave relay of the data traffic is quite compelling; there is really no reasonable alternative that would not require construction of a separate new network. Thus, in some ways the real question is how to structure the regulatory and organizational issues.

One alternative is represented by the approach taken by UNMIL, the UN Military Command, in structuring its private network for communication connections out of the country. It has constructed two microwave relay pathways to carry its communication traffic down to the international gateway in Ivory Coast. They did this by obtaining agreements from the various cell phone providers to rent space on their cell phone towers and use their local power supplies.

This model could apply to any commercial national network for Internet access; Liberia will need to make some decisions about how best to approach the issue of access to the currently private tower networks of the cell phone companies.

3.1.3 Gateway

Moving Internet traffic around the world achieves enormous economies of scale by pooling the traffic of everyone who is logged on into very efficient fiber-optic cables connecting various routing computers, called the global Internet backbone. Thus, when a request by a user in Nimba County to view a webpage hosted on a computer in California connects to the global Internet backbone, it is pooled with messages from millions of other users on the backbone and carried to California. The destination computer's reply is again pooled with millions of other messages and routed back along the backbone until it arrives back to the original address.

The quantity of traffic being processed and the efficiency of pooling the messages together means that the cost of any individual packet's journey is infinitesimally small. However, these economies of scale do not begin until the traffic arrives at the global backbone and it joins the messages of millions of others. Moving the traffic from the national distribution system to the global Internet backbone is the job of the gateway.

Liberia's access to the global Internet backbone is achieved almost exclusively by satellite transmission, which results in a very expensive and inefficient process. Obtaining better international gateway access will make the biggest contribution to improving Liberia's Internet services. There are a range of options for doing this, the most efficient of which would be for Liberia to connect directly to an undersea fiber-optic cable for its gateway services. This might not be the cheapest or fastest way to achieve the improvement, but it would produce the best gateway capacity.

3.1.3.1 PRESENT SITUATION

In industrialized countries, access to the backbone is usually somewhere nearby; moving the data to that location is a small cost. In Liberia's case, however, there is currently no good way to access the international backbone. Determining the best solution will require detailed analysis of traffic projections and costs, but a number of factors are already clear:

- Liberia's traffic is generally carried by satellite to Israel or Europe to connect to the backbone. Satellites are generally the service of last resort, as they are always expensive.
- Using the VSAT approach that is common in Liberia results in a situation in which all the one hop VSAT services that go directly out of the country are in effect mini-gateways for one user, a massively inefficient solution.
- The double hop VSAT solutions, which use one satellite hop to bring the traffic back to Monrovia and another satellite hop to carry the pooled data out to the international backbone, attempt to capitalize on the efficiency of pooling many VSAT users' traffic into a single second hop.
- However, a two hop approach increases the risk of "time-outs", and it is exceptionally expensive in Liberia because it still incurs the cost of the first VSAT hop.

- The solution of pooling traffic and sending it by microwave relay to a nearby connection to the backbone (such as Ivory Coast) is a very reasonable technical approach. It is better than pooling traffic for relay by satellite, but unless microwave relay via cell phone towers is used to also avoid the first satellite hop, there will still be an expensive satellite component.
- This cross-border solution also incurs a recurrent cost for moving the traffic down to Ivory Coast, and the cost of whatever premium the Ivory Coast charges for access to their gateway, though depending on the quantity of traffic and the costs to build and operate a direct cable connection, it could prove to be cheaper than a cable landing in Liberia.

3.1.3.2 DESIRED OPTION

Liberia's Internet connectivity cannot be affordable or efficient without solving the problem of the gateway. The desired technological solution is for the country to use a connection to the submarine fiber-optic cables that now exist or are currently under construction. This could be either by building a direct connection from Liberia to one of the cables, or by carrying Liberia's traffic over land to an adjacent country's connection to the undersea cables. Either of these options could improve Internet performance varies substantially, but both will require resolution of a complex set of issues first:

- With high levels of international traffic, the theoretically optimal solution is for Liberia to connect directly to one of the offshore submarine fiber-optic cables. Building a cable landing point in Liberia would avoid both the problem of latency on satellite links and the costs of carrying all the country's traffic across the border to use some other country's landing point.
- There is no publicly available analysis of the tradeoffs between building a cable landing point in Liberia versus a cross-border solution. A rigorous analysis will need to be conducted.
- The cost of either option will almost certainly be the biggest expense involved with improving Liberia’s Internet connectivity. It could possibly run into the tens of millions of dollars. These funds should come primarily or exclusively from the private sector, whose business model should be to recover these costs over time from the revenues they earn by selling Internet connectivity.
- It is worth noting that the cell phone carrier Lonestar has already applied to the national regulatory body for permission to build a landing point to connect Liberia to the undersea cable being built by a consortium in which Lonestar's parent company, MTN, the South African cellular conglomerate, is an investor. To date, the regulatory body has made no reply to the request. Construction of that particular cable is already underway, and it is projected to be able to begin service in Liberia in 18 to 24 months.
- If a single entity is granted permission to build a cable landing at its own expense, the Government of Liberia will face a complex regulatory task in determining how to assure that other entities also can take advantage of these services at a price that does not disadvantage them relative to the investing company. These negotiations could take a considerable amount of time.
- Decisions about where submarine cables will "come ashore" are usually made well in advance of the time the cable construction arrives at a particular country, and it is

difficult and expensive to engineer new attachments to existing cables. There are several alternative cables covering the coast of West Africa that are in various stages of construction or planning. Liberia will need to make a decision and a commitment more than a year in advance if it hopes to connect to one of these cables directly. Thus the decision-making process must begin soon and move quickly.

- The alternative of connecting to an adjacent country's landing point is a perfectly viable technical solution which might be pursued either as an interim or a permanent arrangement. Such a connection can be accomplished either by microwave relay or by fiber-optic cable. The cross-border option requires less lead time and less construction time than a cable landing in Liberia, but would probably take more than 6 months to implement after the decision was made.
- The organizational structure of, and financing for, any shared cross-border network will require a great deal of coordination with among the potential users.

There is a third technical alternative, which would be to route all of the country's international traffic via the cell phone infrastructure to a single point, pool it, and send it out over a single satellite channel to achieve the lowest cost based on the economy of scale of the aggregated traffic.

- In this approach, the last mile and distribution network solutions of WiMAX locally and backhaul of the traffic over the cell phone networks could be implemented, and the international connection would be accomplished through a single, centrally located satellite hub.
- This does not avoid the problem of satellite latency, but it does at least reduce it to a single hop.
- This is a less attractive solution that could be followed if it proves impossible to arrange a national submarine cable landing point or cross-border connection. However, if a significant percentage of the users are still connected back by VSAT to the satellite hub, it might not be worth the cost or effort.

At the engineering level, choices between the two non-satellite approaches (cross-border or domestic connection to the submarine cables) can be considered primarily as a cost issue based on analysis of future traffic and likely future pricing for the different options. In the real world, of course, the decisions are much more complicated and must take into account financing, security, reliability, politics, and vested interests.

- If the investment capital required is to come primarily from the private sector, this factor alone may weigh very heavily in the eventual decision, not merely because of the challenge of securing capital, but also because of the difficulty in achieving cooperation if investment by multiple players is required to achieve a solution that is better for all of them.
- The view of the authors of this study is that donor funds would be well-spent when devoted to government capacity development in planning and regulation, helping sectoral development activities incorporate the benefits of improved Internet access in achieving their goals, and working with the education system to ensure that graduates emerge with the computer skills that will enable them to take on modern employment.

- That said, however, USAID/Liberia and the other donors might find it most useful to set aside some money to help steer or accelerate action on these choices. If for example USAID/Liberia or the other donors pursue a strategy of leveraging their purchase of Internet capacity for projects as a way to encourage cell phone operators to install WiMAX capacity on the tower is serving the area of the projects, they should probably be prepared to pay something close to current prices for an interim period to induce the carrier to change the tech knowledge. However, the money for basic infrastructure investment should be from private sources or from the regional or World Bank's funds.

During our visit, only one plan of action emerged as already having access to private funding -- the request by Lonestar to build a national cable landing point. The proposal has the distinct advantage of not requiring cooperation among multiple players to be achieved. This solution, if acted on quickly, could probably be up and running within 18 to 24 months. This would clearly be an excellent technical solution, but the situation would require strong regulatory controls to assure that all vendors had open equitable access to the capacity.

3.1.4 Internet Exchange Point

There is one additional element that can help improve the situation for Internet access in Liberia, but it is not technically part of the infrastructure of carrying Internet signals. Communication over the Internet sends packets addressed to specific computers through the network, with routing computers on the Internet backbone determining the best path for the packet to follow. Since all of Liberia's traffic now goes out of the country before it connects to the Internet backbone, every message sent from Liberia to a destination in Liberia must travel out of the country before it can be directed back to the destination computer.

- An Internet Exchange Point looks at all the packets before they leave the country and routes those that are destined for Liberian addresses directly to the receiving Liberian computer, without making the round trip out of the country. In the long run this can reduce the traffic on (and hence the cost of) the international gateway.

- This would have little immediate effect on Liberian international traffic because there are very few Liberian-hosted servers. Almost all Liberia related sites are hosted on servers in developed countries. As the number of local servers grows, the strategy can have an appreciable effect by reducing unnecessary international traffic.

- The reason that there are virtually no Liberia-located Internet sites shows the chicken and egg nature of this problem. Presently, a request originating in Liberia to access a website hosted in Liberia has to make two round trips to Europe -- once to be sent to the Liberian website, and the second time in order to return the reply to the originator. It is much more efficient to locate the Liberian content on a host server in Europe so the extra round-trip to Europe is avoided.

- However, as the use of Internet in the country grows, the proportion of traffic that could possibly be kept internal to the country will grow very rapidly. The establishment of an Internet exchange point could accomplish two things: it could help promote the growth of domestically based Internet services and websites, and it could avoid the expense of sending domestic-only traffic out of the country.

The establishment of Internet exchange point is not technically complicated -- it is merely a server farm that looks at the addresses of all the incoming packets selects those with domestic

addresses and passes them directly to the destination provider. However, certain conditions must be met for it to operate effectively:

- It does require that all domestic traffic be routed to the exchange point, which may require extra movement of the traffic inside the country.
- All or virtually all of the Internet service providers must participate so that the savings can be achieved.
- This will require that the ISPs have a high level of confidence that the exchange will be operated in a way that treats all providers equally, and that the exchange will operate with a high level of reliability.

The real challenges in establishing an Internet exchange point are institutional:

- A neutral organization must be created to operate the exchange;
- The rules of operation and regulatory protection must be established clearly;
- The organization must earn the confidence of the other carriers and establish a collaborative style with its clients; and
- The operator must demonstrate its ability to solve technical problems quickly while maintaining virtually continuous availability.

Overcoming these challenges will take some time, so it will be worthwhile to begin immediately the process of establishing the organizational and technical underpinnings of such an activity. With appropriate planning and training in advance, a well functioning Internet exchange point can come online in time to reduce the costs of domestic traffic and to foster an environment in which Liberia related Web content and services are actually hosted in Liberia.

4 Applications for Development Projects

In this study, the final objective of a reliable high-speed Internet across rural Liberia is to connect more beneficiaries with better services and information through targeted applications in key strategic objectives, especially health and education.

Through this initiative, USAID/Liberia's project portfolio would provide a critical mass of users demand for applications that would a critical mass and a catalytic force that provides a basic demand for Internet services in at least 60% of rural locations outside Monrovia. In this section, we outline some of the ways that activities in education and health sectors, in particular, might benefit from the availability of Internet access. As is the case elsewhere in Africa, the most popular applications that would immediately improve communication and become widely available for the majority of users are:

- **Web searching** for information.
- **Web-based e-mail** from providers such as Gmail, Yahoo or Hotmail. In general, mobile users are the first to sign up or transfer to the online option.
- **Instant messaging and voice over the internet** as natural extension to e-mail would follow e-mail applications. Again, the link between mobile, online and offline users would increase.

- **Online community applications** such as Facebook or Myspace would link people beyond their geographical or linguistic borders across Liberia and beyond.
- **Immediate (two-way) M&E reporting and results dissemination** through an Internet and cell phone based system available to all donors.

Although these services may be regarded initially as intended for personal use, their availability and widespread use has the effect of promoting its business communication, especially among merchants for banking, trade and market information to and from the capital and the rest of the country. The use of e-mail in particular, creates a whole new "written" business culture that makes formal transactions possible. Written communication becomes a form of tracking decision and promoting widespread collaboration and democratization of public affairs.

4.1 Education

In the education sector, there are many goals for application development that would benefit from a reliable Internet connection, among which we wish to emphasize two points:

- **Improve the quality of education services for teachers and students** through online training, open access to information (such as having Liberia join the African Education Commons), distance learning and testing; and
- **Support decentralized management of the ministry offices** through basic institutional systems for decision making.

First, the study would emphasize the importance of proposed applications designed to improve the quality of education especially focused on teacher training for basic and secondary level education through targeted investments in ICT in the following areas:

- Establish **online teacher resource centers** based in the Rural Teacher Training Institutes. These centers with use standard computer laboratories at the rural teacher training institutes to serve as for online research, testing and certification units. A standard room with 12 to 20 computers would be connected via high-speed link.
- Expand **learning resource centers** developed under the ALP Plus program to reach out of school youth and other young professionals in alternative sites such as professional development programs in community centers, churches or cybercafés managed by private entrepreneurs with detailed regulation and work.
- Develop **multimedia and research applications laboratories** from 7th through 12th grade student online research and computer training as well as support life skills training and information exchange. A set of light computer stations and netbooks would permit access to education portals in Liberia or elsewhere.
- Develop an interactive ministry **portal** offering services including joining the African Education Commons to open access to information for all educators in Liberia and abroad.
- Externally through public **blogs, online forums and feeds** that collect and disseminate innovative education policy discussions, promote international donor participation and enable an outreach to Liberian community overseas.

Second, the Ministry of Education could improve the management of its schools through an online education information system (EMIS) to track student enrollment, teacher attendance,

testing results, budget planning and execution among other areas. An online EMIS would help provide rapid response to specific information to track schools and enhance decision making for policy planning and evaluation. During the current mission, the team met with a group of EC ICT experts housed at the MOE working on the core applications supporting information compilation. EMIS services can be expanded to internally to **accelerate decentralization** of services such as school registration, teacher, personnel management, census reports and financial reporting.

These applications would be designed into the current project objectives to enable student-teachers up-to-date information at the RTTIs, provide out of school youth access to engaging courses outside conventional classroom and ensure middle school students reap the benefits of connectivity not to external sites but also domestically among each other and with the central site in Monrovia.

4.2 Health

Given the rapid pace of emerging health threats and need for a timely response, the health care sector stands out as the immediate beneficiary of an improved and reliable Internet access. The projects serving the health sector require up to date information on diseases, treatment and follow up evaluation particularly in remotes areas outside of Monrovia or major county hubs. Just as with the education sector, the ministry of health would benefit from a multiple approach to Internet-enable applications that:

- Improve the **quality** of the health services provide through access of *online training* materials for rural health care providers, diagnostic tool for telemedicine and post-intervention follow up.
- Increased **efficiency** of the management of the Ministry's resources through a decentralized management connected to most health post workers with accurate information systems.
- Improve **responsiveness** to health threats through rapid response management teams that can send the required medicine and technical assistance in case of emerging epidemics in remote areas of the country.

County Health officials, health care providers, local health promoters and even patients can request up to date information on the specific treatments, required medicine or prevention measures. Access to online information can improve diagnosis of patient illnesses, process supply orders and track recovery. The type of applications envisioned in the three areas described above can be summarized in the following list:

- Improved **early detection and prevention systems** for health post workers using a variety of interface devices such as handheld PDAs or highly portable computers with database information systems.
- Internet-enabled **community training facilities** with offline/online media resources and digital video library to help train rural health care workers, community promoters and parents on the malaria, community health and immunization campaigns among others.
- **Continuing education training centers** with online certification programs for community leaders in malaria and tropical diseases.

- Development of **health training centers** at every county office of the Ministry of Health and other key population hubs. These centers would operate as part of training facility for health promoters.
- Establishment of **maternal and child health care** information systems for early detection and prevention treatments linked to the Ministry of Health tracking system and for communication among health care workers in rural communities.
- Introduction of **wireless handheld PDAs or netbooks** for health promoters with database information systems enabled to capture and relay time sensitive information regarding vaccination programs, malaria prevention or detection of HIV-AIDS.
- Development of **Internet-enabled social behavior campaigns** through local Internet café with media campaigns for information dissemination to youth and young adults.

5 Alternative Approaches The Government Of Liberia And USAID/Liberia Might Take To Improve Internet Access

The Government of Liberia has undertaken a number of programs that demonstrate its commitment to using ICT for development and for developing appropriate institutions to regulate and serve the telecommunications sector. The breadth of their commitment is impressive; it seems reasonable to expect a strong level of interest in the objectives described in this report. The first necessary action in this context is for the GoL and USAID/Liberia to open a conversation and determine the priorities of the government related to these issues. If the government ultimately decides to request assistance from USAID on these matters, the actual strategy for intervention would follow directly from the government's priorities.

The purpose of this quick assessment is to facilitate informed thinking about what those alternatives might be. In order to do this, the assessment team made some assumptions about what different objectives the government might have, and articulating strategies that would be representative for that general area of government interest. Three such strategies are outlined below. All of them share common goals, but differ in the approaches and intensity they devote to specific problems.

5.1 General Goals

It is assumed that the shared general goals of a GoL and USAID/Liberia intervention might include the following:

- Accelerate the solution of the problems currently affecting Liberia's Internet access
  - promote the adoption of a more efficient last mile technology
  - rationalize the distribution network for carrying Internet traffic from the user to the international gateway
  - facilitate the transition to a modern, high bandwidth international gateway
- Put Liberia's communication sector on a solid path for Liberia's future through studies and action in the following areas
  - policy formulation
  - regulatory controls
  - private sector funding

    - optimal technology choices
- Accelerate the utilization of communications and Internet access in support of development objectives
    - adoption of sectoral applications
    - information technology training in the formal school system
    - in-service professional training
    - equity of access for the public, especially in rural areas

5.2 The Range Of Alternative Strategies

In pursuit of these general goals, we are assuming there are three strategies the GoL might choose to follow. They differ primarily in the intensity of near-term efforts to improve the performance of Internet access in Liberia:

- **Strategy One**: this strategy prioritizes an organized approach to fundamental improvements in the Internet infrastructure major commitments to building the capacity of government agencies and ensuring that the improved Internet services are quickly taken advantage of.
- **Strategy Two**: this strategy sets less ambitious goals for modifying the infrastructure and focuses on gradual improvements while still working to build capacity and promote applications of ICT for development.
- **Strategy Three**: this strategy does not prioritize changes in the technical infrastructure of Internet, but still focuses on capacity development and applications.

In order to summarize a great deal of information succinctly, we are presenting the detailed descriptions of the strategies in a series of three tables, each of which is intended to highlight a separate aspect of the strategies The first describes the strategies in terms of the intensity of focus the strategy would have in different areas of focus. The second characterizes the strategies by what problems they would address, and the third by the activities they would undertake.

The earlier part of this document outlines a number of areas of focus that any integrated strategy would need to address. The following table shows how these areas of focus are treated under each of the three strategies, using the symbols "**+++**", "**++**", and "**+**" for strong, moderate, and low levels of effort, respectively.

In each of these areas of focus, the government's specific priorities would determine the immediate objective. In particular, in the areas that involve regulatory policy and relations with the private sector organizations delivering Internet service, even the specific priorities would have to be determined in multi-stakeholder conversations.

Area of Focus	Strategy One	Strategy Two	Strategy Three
Last Mile Connections	+++	++	+
Distribution Network	++	++	+
International Gateway	+++	++	+
Internet Exchange Point	+++	++	+
Policy and Regulatory	+++	+++	+++
Capacity Development	+++	++	+
Development Applications	+++	+++	+++

Technical alternatives will generally need to be assessed by detailed assessments of cost and performance among the alternatives. The establishment of regulatory policy is an especially complex example, because it represents an area where national policy, legal constraints, large numbers of stakeholders, and financial considerations all converge. This situation implies that a project working in this arena would find itself in a fluid environment where the final objectives will only be determined during the intermediate stages of the project.

For this reason, we are also defining the different strategies **in terms of the problems they would be addressing**, rather than the specific outcome that would result. The following table, "Characterization of the Different Strategies," characterizes the three strategies according to the particular problems they would be tackling. These might be thought of as the conceptual definitions of the efforts.

The somewhat longer table that immediately follows, called "Detailed Description of the Strategies," provides a third perspective on the definition of the strategies **in terms of the activities they would undertake**. These can be thought of as the more conventional programmatic description of projects.

CHARACTERIZATION OF THE DIFFERENT STRATEGIES			
	Strategy One	**Strategy Two**	**Strategy Three**
General Approach	• GoL sets ambitious goals for improving structure, performance, and pricing of Internet infrastructure • USAID provides energetic support to GoL efforts • USAID provides information and coordination support to development community • Promotion of appropriate developmental use of ICT throughout Liberia • Capacity development concerns addressed	• GoL sets more modest goals for changes to Internet infrastructure • USAID provides structured program of support to GoL goals • USAID is systematic in the use of ICT within its own portfolio • Attention is paid to issues of capacity development • USAID plays informational support role to development community	• GoL does not prioritize reform of Internet infrastructure • USAID provides policy and consulting support on an as-requested basis • USAID utilizes ICT where available and appropriate • GoL and commercial capacity development in ICT not prioritized
Infrastructure Objectives	• Last mile: coordinate demand pull to achieve WiMAX platform for data service • Distribution network: utilize the cell phone towers for carriage of data • International gateway: accomplish shift to cable landing site or cross-border connection to submarine cable	• Last mile: work with cell phone companies to assure widespread availability of cellular data protocols • Distribution network: data backhaul over cell towers • International gateway: support analysis of options; assume slower progress toward solution	• Last mile: use cell phone data protocols when and where available; otherwise no change • Distribution network: no special focus • International gateway: resignation to current situation
Support of GoL& USAID Efforts	• Structured program of active support to GoL efforts • Separate resident advisors for technology, policy, and applications • Active training programs for regulatory and ICT specialists in government	• Structured, less intensive program • Single resident advisor to provide advice, coordinate consulting assistance • Training for regulatory agency	• Consulting support if GoL requests it • Training for regulatory agency
Applications	• USAID incorporates expanded use of improved ICT capability within own portfolio • USAID helps GoL design ICT adoption into government programs	• USAID systematically uses improved ICT where available • USAID provides advice GoL on adoption of ICT	• USAID portfolio continues on current path • No special focus on GoL adoption of ICT
Timeline	• Training and support elements begin immediately; infrastructure elements take approximately 18 months before biggest improvements arrive	• Training and support elements begin immediately; modest infrastructure improvements disseminate gradually during first year	• Training and support elements begin immediately; little infrastructure improvement expected

DETAILED DESCRIPTION OF THE STRATEGIES			
	Strategy One	**Strategy Two**	**Strategy Three**
General Description Of The Strategy	• Make concerted effort to solve Internet infrastructure problems • Provide strong regulatory consulting support • Facilitate associated changes for GoL computer adoption and implementation of ICT policy • Facilitate national effort to create training institutions for technical personnel • Promote adoption of Internet and ICT use within projects	• Support GoL consideration of Internet infrastructure changes • Provide strong regulatory consulting support • Provide supportive consulting and educational inputs for GoL ICT adoption • Promote adoption of Internet and ICT use within projects	• No focused effort on reform of Internet infrastructure • Provides strong regulatory consulting support • No centralized effort for GoL ICT adoption; may occur at project level • Promote adoption of Internet and ICT use within projects
Last Mile Technology	• Coordinate with cell phone companies on national WiMAX adoption strategy • Coordinate with GoL and donors on standard procurement policy for local last mile connections • Specify requirements for local connections at true broadband levels	• Support long-term planning for improved last mile connections • Coordinate with cell phone companies on the improved availability of cellular data service (GPRS, EDGE, or CDMA) • Specify requirements for cellular data performance near nominal capability • Provide information to G0L and donors comparing performance and pricing of cellular data versus VSATs	• Coordinate with cell phone companies on improved availability of cellular data service • Specify requirements for cellular data performance near nominal capacity • Informational effort making people aware of the trade-offs between VSAT and cellular data
Distribution Network	• Support planning and implementation of move to rely on cellular towers as core of national telecommunications grid • Support planning and implementation of expansion of separate data backhaul via cell phone towers	• Coordinate with individual cell phone companies to improve data backhaul • Provide informational support encouraging people to avoid two hop VSAT connections	• Informational focus only

International Internet Gateway	• Technical and policy studies analyzing move to either national cable landing point or cross-border connection • Consultation support to regulatory efforts required to accomplish improved gateway • Facilitate arrangement of private funding for construction of improved gateway	• Provide consultation and studies in support of GoL consideration of options for improved gateway • Include option of pooling national traffic for single satellite hub gateway service	• Provide consultation on improving efficiency of existing solutions
Internet Exchange Point	• Consultation and planning support for design of IXP • Facilitate establishment of neutral body to operate and training of necessary personnel • Assist in procuring required technical equipment and beginning operations	• Support design study preparing for eventual implementation	• No involvement
GoL Capacity Building	• High level of consultation and training support focused on regulatory policy and implementation • Consultation support to GoL efforts to implement government computerization • Design, perhaps implement training programs in computer use for government staff	• Consultation and training support to regulatory body • Consultation to government in support of ICT adoption efforts • Support preparation of stand-alone training materials in computer literacy for government employees	• Consultation services to regulatory agency
Appropriate Applications	• Support government consideration of how to build in appropriate use of information technology and service delivery • Deliberate use of available ICT enhancements within USAID program portfolio • Coordinate communication among donors to enhance awareness of improving availability of ICT that can support program goals	• Consultation for government ministries on request concerning how best to use ICT • Informational efforts within the government and development community concerning appropriate applications and availability of improved connectivity • Deliberate use of ICT within USAID portfolio	• Use of available communication and Internet within USAID portfolio

Technical Manpower Development	• Consultation support to government for estimating level of need for technically trained personnel to support broader use of ICT throughout country • Facilitate planning for establishment of appropriate training institutions to create necessary manpower pool • Support the creation of such institutions	• Planning studies to assess future technical manpower needs • Assist government and private sector in analyzing how to meet those needs	• No involvement
Formal Education System	• Consultation and planning support to GoL concerning ways to assure that youth coming out of education system are experienced computer users • Systematic use of ICT for remote and in-service training of teachers and educational administrators • Development of plan for eventual expansion of computer labs in schools	• Consultation to GoL on issues related to training computer skills within schools	• No special involvement

5.3 Discussion of the Strategies

The remainder of this section discusses special characteristics were issues related to each of the strategies separately. It does not attempt to repeat the full description of the project as contained in the "Detailed Description of the Strategies" table above; rather, it identifies some of the uncertainties or challenges that are implicit in the more concise descriptions above.

5.3.1 Strategy One

The core objective of Strategy One is to bring the Internet infrastructure of Liberia up to an international level of performance as quickly as possible. This implies introduction of the modern, data-appropriate last mile technology like WiMAX wherever a full Internet service is desired and connecting the country by undersea cable to the global Internet backbone to provide a high-bandwidth, low latency connection. The infrastructure of the cell phone tower networks would be used as the distribution network, and might require some beefing up to handle the increased data traffic. USAID/Liberia would provide strong support to the Government of Liberia in pursuing its goals to fix the technical deficiencies of the communication network as quickly as possible through the private sector, and to employ that functioning communication and Internet capacity in the service of development.

5.3.1.1 CONSIDERATIONS RELATED TO INFRASTRUCTURE GOALS

The infrastructure goals are ambitious, upgrading the elements of the technological chain to levels that will serve as an excellent platform for Liberia far into the future. This is the most logical approach, as it avoids new investments down the road to replace interim solutions, but it may be viewed by some as providing a level of capability that Liberia does not yet need. In those cases where significant capital investment is required to achieve the change, it is expected that the investment capital will come from the private sector perhaps in combination with loans from the World Bank or regional development bank.

Each of these elements reflects a possible bottleneck in achieving reliable broadband Internet connections, and each must be functioning well to achieve success. It makes little sense to invest in an improved last mile capability if the bottleneck of the international gateway continues to limit overall performance. This strategy is the only one of the three that would be able to accommodate active use of the Internet by numerous institutions, such as computer labs in schools or commercial public access at cyber cafés.

The overall strategy here is to build on as much existing infrastructure as possible, and to rely on the strongest existing organizations as partners in the strategy. In practice, this means collaboration with the cellular telephone providers, as they are the owners of most of the existing infrastructure and the strongest organizations in the sector. This will have disruptive effects on ISPs that provide access in rural areas by VSAT, as the rational move is to utilize the cell tower networks for "backhaul" of the data traffic to the gateway. Non-cell phone company providers could remain competitive by adopting WiMAX and being permitted equitable access to the cell towers of their competitors, but there are obvious organizational and commercial disadvantages to this, even if the regulatory structure to permit it could be worked out.

There is reason to believe that at least some of the cell phone companies would look positively on a conversion to WiMAX for data connectivity. In conversations with two of the cell phone companies (Lonestar and Comium) the company CEO suggested without any prompting from

us that they thought WiMAX was a more appropriate technology for Internet access than the services they were currently selling.

At the moment, only one cell company (Lonestar) is currently licensed to deploy WiMAX, in part as the result of a negotiation that took place at the time of the harmonization of the cell companies' licenses. One interpretation of that negotiation that was offered to us reported that under the harmonization process, all of the cellular providers were to get equal licenses of the same duration for the same price. Apparently at least some of the three smaller carriers objected that because Lonestar had been in operation for a longer time than the others in the period prior to licensing, that it was in fact being given a longer license for the same price and should be required to pay more. The eventual solution was to require Lonestar to pay an additional $5 million, but to give them a WiMAX license in return for that. Strong leadership in the regulatory arena will probably be required to correct this anomaly and ensure that all of the providers are permitted or encouraged to establish WiMAX as the standard means of providing data connections.

There will be several challenges associated with how to achieve standardization in the implementation of WiMAX:

- Regulation in Liberia is based on "technological neutrality", which means that the government does not tell operators what kind of equipment to use but rather specifies the performance requirements and lets vendors choose what they think is best.
- If USAID employs a strategy of aggregating demand and specifying performance requirements that virtually require WiMAX, the effectiveness of that strategy will be undermined unless the majority of other donor organizations also utilize the same specifications.
- In many countries cellular operators have paid very substantial amounts for licenses to deliver 2.5 G. and 3G cellular data services, which leads them to stick very strongly to a plan to utilize cellular data protocols that they have already paid for rather than adopt a more appropriate technology. Our understanding is that this is not the case in Liberia, but if it is it would take some rather agile regulatory maneuvering to purchase back those licenses or define their scope more broadly.

These considerations notwithstanding, the preferred strategy for last mile connections would almost certainly be USAID/Liberia collaborating with the Government of Liberia to achieve quick regulatory resolution of the relevant issues, and proactively organizing the consumer side of the market to demand service levels that are consistent with their needs and also consistent only with modern data-appropriate technology.

There are two good approaches for fixing the international gateway problem -- a national submarine cable landing or a cross-border circuit by microwave or fiber-optic, probably to the landing station in Ivory Coast. There will be technical, political/regulatory, and financing issues that must be carefully assessed in order to make a correct decision about which of these approaches would be preferable. At present, the only option that appears to have funding associated with it is the cable landing point proposed by cell phone company Lonestar. To be a viable option, a relatively quick commitment will be required to stay within the schedule for laying the cable. Presumably, prior to making such a commitment, the GoL would need to establish firm regulatory guidelines to ensure that all vendors have equitable access to what would become the de facto national gateway.

In terms of timing, the cable landing point solution requires a commitment with substantial lead time in order to make provision for a spur from the cable to come ashore in Liberia, even though the cable laying will not occur until sometime later. In addition, building the shore facility will also require lead time, but it can be begun well in advance of the arrival of the physical cable. It is probable that it would be at least 18 months after commitment is made before service could begin.

It is within Strategy One that the possibility of creating an Internet Exchange Point (IXP) has the greatest payoff. Solving the gateway bottleneck means that Liberian providers of content could start hosting servers in Liberia so that domestic traffic did not have to make two round trips to Europe to reach a Liberia-located server. In the beginning, the small number of Liberian providers of content will not provide much savings through the IXP, but it will serve as a stimulus for providers to begin to locate services in Liberia. Given that the IXP is a novel type of organization in Liberia, and that few appropriately trained staff exist, starting the IXP early in order to give the organization a chance to mature is probably a good strategy.

During the initial year or two years of the project, the demands for technical support with a very strong background in telecommunications technology and data communication will be very high, not merely for qualified assessment of technical options, but also for assisting in procurement specifications and negotiations with providers are carriers. This suggests the need for a full-time telecommunications technology expert, at least for the first two years of the project.

5.3.1.2 Considerations Related To Capacity Development and Technical Support Goals

Appropriate roles for USAID/Liberia support to the telecommunications and ICT sector efforts of the Government of Liberia are twofold: one is to assist in the formulation of policy through technical assistance to the government offices involved, and the other is to engage in systematic training programs that prepare the organizations involved in policymaking and regulatory determinations to better perform these roles in the future.

The regulatory agency should play an absolutely pivotal role in establishing the procedural steps and boundaries in the sector; USAID should give high priority to providing technical support to this organization. We have mentioned a number of the specific issues that will arise concerning common carrier status, transparent pricing under conditions of local monopoly, preservation of competition within the sector, and the recognition of some scarce resources as matters of national concern that require regulation. These kinds of challenges almost certainly imply the presence of a resident advisor with very strong skills in the regulatory arena.

In addition to the formal capacity development for government employees, there are a host of technical training needs that are vital in preparing the country to use and maintain information and communication technology. An obvious response to this would be the creation of technical training institutions for all levels, from computer technicians to internetworking specialists. USAID may find it useful to coordinate with other donors who share these perspectives and needs and may wish to take a leadership role in addressing some subsets of the needs.

At another level there will be a massive need for individual users to be trained, both within the government and in the commercial sector. USAID may find it productive to contemplate creating training materials under the auspices of one project but making them available on a national level to others who need training. Finally, the detailed description chart alludes to including computer literacy and applications training within the formal school system. While it is not

expected that USAID would tackle that objective within this project, the preparation of a modern workforce represents one of the biggest benefits from improving the level of Internet connectivity in Liberia. In-school activities should figure strongly in the planning and materials preparation under this project, even if another project or donor takes responsibility for it.

5.3.1.3 CONSIDERATIONS RELATED TO DEVELOPMENT APPLICATION GOALS

The main objective of improving the area of Internet connectivity in Liberia is to use it to amplify the impact of Government of Liberia and donor agency programs. Poor quality or unavailable Internet services directly hamper the ability of projects to run efficiently and accomplish the objectives they have set for themselves, and indirectly discourage development projects from even setting goals that, while appropriate and that desperately needed, can't be undertaken in the absence of decent connectivity. USAID/Liberia should consider activities at three different levels in this context:

- actively examine its own projects to identify the opportunities to make use of Internet connectivity to support existing objectives and to undertake approaches that were previously not possible;
- actively train representatives from the GoL and help them develop strategies for delivering services in such areas as pre-service and in-service training, information resources, remote data gathering, and management communication; and
- consider carrying out informational activities to disseminate best practices and create a community of interest among Liberians, NGOs, and other donors to encourage them to take advantage of the improved Internet connectivity that USAID is facilitating.

The same general principle, that of maximizing the benefits that result from the effort being invested in improving Internet, applies to the issue of access by the general public. The general public is surprisingly swift to adopt some aspects of the Internet, including communication with family members who have migrated to urban areas or other countries seeking work, which often results in a significant increase in remittances to those remaining in rural areas.

Finding ways for the public to have access may or may not be included in the formal objectives of the project, but in any case should figure in the planning. For example, the facilities installed to support development project activity might be open to the public at certain times to allow them to learn how to use computers, send and receive e-mails, and seek information. In some countries, municipal government offices are equipped with several computers that are made available for public access. If local law permits, small fees charged to the users can help defray the operational costs.

Some kinds of small government incentives might be used to help draw entrepreneurs into the business of establishing public cybercafés to allow public access. Similarly, the availability of adequate computer facilities in public schools will take time to accomplish; public facilities or private cybercafés can be used by teachers for their own in-service training, and by students to develop their computer skills for future employment. This has the synergistic effect of providing a kind of market development for cybercafé operators -- these early customers helped them to survive through the lean times as they establish their business and build a customer base.

5.3.1.4 CONSIDERATIONS RELATED TO IMPLEMENTATION

Without clear guidance from the Government of Liberia, no definitive description of staffing needs, technical assistance activities, or other required resources can be offered. However, with the ambitious goals of Strategy One, it appears that it would be necessary to have substantial on-site technical assistance for sustained periods in three areas: technology, regulation, and applications. These are sufficiently different skill areas that it is unlikely that the same person would be appropriate in multiple areas. In addition, the required levels of skills are quite high; it seems unlikely that appropriate staff could be located in Liberia at the present time. Thus, it is likely that the project will lead three experienced resident advisors, although not necessarily all of them for the full duration of the project.

Much of the eventual work of the project aside from the leadership of these resident advisors will probably be episodic -- specific needs will emerge that can be met by short or medium term consultants. One should assume that a substantial budget covering a very broad range of consultants will be required.

Under Strategy One, there are some activities that will produce tangible improvements quite quickly, particularly in shifting the last mile connections to data-appropriate technology. The overall process of redirecting the path of the telecommunications sector in the context of Internet connectivity will require sustained attention over a period of at least several years. Identifying the technologies, sorting out the institutional relationships, selecting and procuring the hardware, installing it, building the capacity to maintain it, and ensuring that an effective regulatory environment is created will take a substantial amount of time. Similarly, developing a new vision among development workers who have never known or have grown accustomed to the unavailability of reliable communications is not a simple matter of telling them about it. Designing and implementing efficient government services and development activities is the reason to invest in improved Internet connectivity, but ongoing support will be required to ensure that new projects successfully problem solve and become institutionalized. These considerations suggest that a project duration of four years minimum would be advisable. Technology and regulatory questions will dominate the first half of that time, while capacity development and applications questions will dominate the second half.

5.3.2 Strategy Two

The second strategy addresses the possibility that the Government of Liberia might choose not to prioritize an overall reform of the Internet infrastructure. In this scenario, they choose to study the options that might be available for fixing the gateway but not to make a quick commitment that would enable the adoption of the cable landing point strategy. If the international gateway does not undergo a substantial improvement, then the overall system performance and costs will still be unattractive. This implies that there would not be as large an immediate return for investment in improving the last mile capability.

Hence, the linked changes in this strategy are that USAID would offer strong support to the GoL for a rigorous study of the available gateway options, but not expect a quick decision. The focus on technology solutions would be scaled back, but parallel focus on capacity development and development applications should be maintained in preparation for the eventual improvement of the overall system.

The generic considerations included in the discussion of Strategy One are also relevant to Strategy Two and will not be repeated here.

5.3.2.1 CONSIDERATIONS RELATED TO INFRASTRUCTURE GOALS

If the analysis of gateway options indicated that a cross-border solution was attractive and feasible, this option could still provide a pathway to major improvements in the overall Internet connectivity performance. At the point at which it was known that the gateway bottleneck would be solved, Strategy Two should begin to promote implementation of an improved last mile technology such as WiMAX as well. Until that point however, Strategy Two should assume that reliance on cellular data protocols would be the optimal method of improving last mile performance within the constraints of the gateway bottleneck.

The utilization of cellular data protocols like GPRS, EDGE, HSPA, LTE, and CDMA EVDO can offer Internet connectivity levels that are appropriate for individual users, but of less value for connecting networks like school labs or Internet cafés. When providers have implemented them correctly and not oversold the capacity to too many subscribers, they will support modest web surfing for individuals as well as messaging and e-mail. This level of performance may incline USAID and the GoL to focus more on administrative communication than on information access or in-service training.

This strategy also as the de facto impact of shifting virtually all of the provision of Internet connectivity onto the cell phone infrastructure, and hence probably on to services provided by the cell phone companies themselves. This may cause a major realignment among commercial players in the ISP space.

In principle, adding cellular protocol data radios to the tower network to provide these services should be the same amount of work and expense as adding WiMAX, so one might expect that a rollout could be completed within a year, or more gradually if the services were only rolled out as demand developed. Before committing to cellular data protocols however, a careful cost analysis should be performed -- it might prove that moving directly to WiMAX service despite the fact that its full potential could not be utilized would still be an economically more advantageous approach, because the lifespan of the equipment is fairly long.

5.3.2.2 CONSIDERATIONS RELATED TO CAPACITY DEVELOPMENT AND TECHNICAL SUPPORT GOALS

The basic objective of offering capacity development for government organizations and technical support to those implementing the new system or designing projects to take advantage of it remains the same. Internet service will probably improve markedly for low data rate requirements, and this improvement will undoubtedly accelerate the demand for still further improvements. For that reason, efforts to prepare a user base within government organizations that understands and can design ICT supported government services should be paired with a reduced but still active program of technical sport for the development of applications.

The regulatory agency will continue to play a central role as this smaller improvement in Internet capacity is implemented, and they will be called on for even more complicated determinations when the eventual migration to a more modern technology becomes possible. For this reason, there should be no reduction in the intensity of support and training for the telecommunications regulators.

5.3.2.3 CONSIDERATIONS RELATED TO DEVELOPMENT APPLICATION GOALS

The nature of some projects might change because of the limitations of the hardware. For example, in-service training of health post personnel would probably be "media rich" if the Internet bandwidth were available to support it. The education goals would be best supported by the inclusion of photographs and video clips covering the topic at hand. However, remote in-service education would still be a very reasonable goal under the more limited cellular data protocols -- one could merely distribute physical CD-ROMs with the media rich content, and use the more limited Internet connection to support mentoring by remote physicians and peer-to-peer communication among health workers taking the course.

5.3.2.4 CONSIDERATIONS RELATED TO IMPLEMENTATION

The less intense level of activity in the areas of technology and applications imply that these needs can be addressed largely by short and medium term consultancies. Support to the regulator will require ongoing contact and a deep understanding of the surrounding context, so that position will still require a long-term resident advisor.

If the decision-making process for selecting between fast action on a cable landing point versus a cross-border connection or a deferral of a decision on the gateway happens quickly, the cellular data protocol hardware can conceivably be rolled out to areas of immediate need quite quickly. If this proves to be the case, then the duration of the project might be able to be shortened down to three years.

5.3.3 Strategy Three

The third strategy envisions a situation in which the Government of Liberia says that it does not consider the improvement of Internet to be a sufficient priority at the moment, and/or that they are not prepared at this time to tackle the complexities of what is certain to be a tumultuous regulatory environment. That would result in the maintenance of the status quo for the international gateway, which would continue to provide a serious limit to overall system performance, with no immediate expectation for evolutionary improvement. With no promise of being able to reduce the gateway's performance hit, the case for improving last mile capacity is not very compelling. A strategy of relying on cellular data protocols at reduced speeds would be an appropriate response, but would have implications for the nature of projects that might be planned or implemented.

5.3.3.1 CONSIDERATIONS RELATED TO INFRASTRUCTURE GOALS

Inability to provide improved throughput will almost certainly have a negative impact on the rate of growth of Internet service demand and Liberia. With the prospect of slow growth, cell phone companies would not be as enthusiastic about making investments in cellular data capacity. Ironically, this might make an investment in technical assistance to the cell phone providers more valuable, by demonstrating the value of investment in advance of demand. A modest level of technical consulting resources should be retained even in Strategy Three, particularly to help support assessment of possible improvements that might interest the government even if they were not prioritizing these objectives.

5.3.3.2 Considerations Related To Capacity Development and Technical Support Goals

Capacity development for government employees related to computer literacy and planning skills for ICT supported government service delivery should continue, but at a lower level. The objective here would be to develop informed professionals within the government who would be able to help assess when the time would be ripe to make Internet performance a priority.

For those kinds of services that coexist well with low throughput rates, such as communications, logistics, remote data entry or access, etc., a modest level of technical support should be offered to government counterparts.

5.3.3.3 Considerations Related To Development Application Goals

Applications like management information systems that are often employed in health and education sectors are good candidates for this environment. In many cases, much of the data only changes annually, so there is not a continuing high flow of data. Low-level needs like this can be met by e-mailing attached database files or even texting directly from the cell phone into the database.

Similarly, hybrid systems in which some content is delivered by CD-ROM or is stored in advance on hard drives and delivered to the field for later use in conjunction with connectivity at the e-mail level can be quite effective for information access and in-service training. For these reasons, resources to help support program design should be included.

5.3.3.4 Considerations Related To Implementation

The less ambitious level of objectives associated with this strategy makes it much easier to have an impact quickly, but with a correspondingly lower level of effect. Probably the highest levels of need for ongoing technical assistance in this strategy will come from the regulatory agency, so the likely choice for skill set requirements for a resident advisor would be in policy and regulation. A duration of two years would probably be adequate unless there appears to be progress towards giving priority to reforming the Internet infrastructure.

6 Next Steps

This study has ascertained that there are significant benefits to improving the performance of Internet connectivity in Liberia, and that there is a range of feasible technical options that could produce substantial improvements. The choices among these options are highly dependent on the details of the technical and policy environment. The next steps should be to sharpen the focus in several areas where important details need to be clarified, in order to establish parameters for USAID decision-making.

The first of these areas should be coordination with the GoL in order to share the findings of this assessment and inquire what their priorities and expectations might be. A great deal of activity and responsibility would be placed on the shoulders of the regulatory agency, regardless of what option was selected. Rebuilding and strengthening the technical performance of that agency would need to be a central objective of any activity initiated in this arena. In addition to supporting the work of the regulatory agency, which implements policy, they would need to be a strong working relationship with one or more counterpart agencies that are involved with the formation of policy, and whose support would be vital in any implementation phase.

A second, and parallel set of next steps needs to be undertaken to clarify a series of cost and technical questions that would determine the starting point and objectives of an initiative. The biggest cluster of technical questions surrounds the alternatives for improving the international gateway, because the level of improvement of that element sets the basic parameters for how much of the overall system can be improved, and hence how much effort should be devoted to the other areas of infrastructure, to capacity development, and to development applications.

A rigorous technical study of the trade-offs and costs between a cable landing point versus a cross-border microwave or fiber optic network would make a big contribution to focusing the terms of reference for future activity. Such a study could be conducted as the first step of an initiative, or as a pre-project activity in order to permit a tighter definition of project goals. It would need to resolve not only questions of technical capacity and cost, but also of the willingness of commercial partners to collaborate, the timetables for decision-making and service initiation related to the different options, and the available financing that could be applied to a selected option. Clarifying the parameters of choosing a technical approach would also provide a clearer understanding of the regulatory actions that would need to be taken, which would in turn feed into selecting the priority objectives for an initiative.

While this initial study would set the main direction for an activity, there will be numerous "branch points" in the process of achieving overall improvements in the technical infrastructure. One might think of the process as carefully "picking a path" through a series of challenges and obstacles. The project should be designed in such a way as to give flexibility for realignments of activity as successive branch points are passed.

Regardless of the pathway that ultimately emerges, this activity has the potential to expand and restructure the Internet infrastructure in ways that will provide immediate and significant strengthening of the development work that is now going on in Liberia.

7 Appendices

7.1 Report of Field visit to Ganta, Gbarnga and Kakata, May 16th and 17th, 2009

7.1.1 Purpose

- Observe and analyze connectivity supply and demand in three major hubs outside of Monrovia in order to gauge the type of applications, bandwidth and potential beneficiaries of a fast Internet service.

7.1.2 Activities

- Analyze cellular phone coverage along the route between Monrovia and Ganta
- Visit cybercafé and computer laboratory managed by United Nations in Ganta
- Observe border crossing with Guinea to understand potential demand from GoL
- Visit the ALP Learning Resource Center in Gbarnga
- Visit and interview PCV at Phebe Hospital
- Visit and interview IT Manager at Cuttington University
- Visit Kakata Rural Teacher Training Institute to interview Director Sulle about the needs for computer training and connectivity

7.1.3 Findings

- **Cellular phone coverage** was adequate in 95% of area covered during the trip. Along the road from Monrovia to Ganta, the team observed adequate to good signal in most urban hubs. There were two sections north of 10km each north of Gbarnga where no cell phone coverage was detected. Signal strength, especially from Lonestar, was very good, although other cellphone towers from Comium, Cellcom and Libercell were noticed along the way. In the case of data services (GPRS, EDGE), it was not available along the road until we reached the major hubs.
- **Internet café** using EDGE technology with extremely slow performance. Visit to cybercafé in Ganta – The cybercafé is on the main road at the entrance of the city of Ganta, across from the UN compound. The Internet café had five computers with an Edge mode. Usage rates posted outside the room with prices ranging from 30 US cents per 15 minutes to $1 USD for 60 minutes. During our visit the café was empty except for one local business man who was trying to type an e-mail on Yahoo to his counterparts in Monrovia. We tested the speed. The speed was very slow (more than 1500 ms latency) and more than 15 hops to arrive at www.aed.org.
- **ALP Learning Resource Center** serving youth with adequate connectivity. On Monday morning, we arrived early at the ALP Gbarnga learning resource center to visit the computer laboratory. The LRC director was out of town, but the computer lab manager

was present at 8:30am. The computer manager told us the lab operated with a generator from 9am to 5pm. They operated a dedicated VSAT connection served by Consolidated Group, just like the LRC in Monrovia. The computers were all operational and loaded with the MS office and Internet Explorer. During our visit, we were able to verify that a) the speed of the Internet in each terminal was adequate for the basic surfing (1080 milliseconds ping, 0.2 Mb/s Up/.03 Mb/s Down), but relatively slow for major businesses and other practitioners.

- **Visit Phebe Hospital in Gbarnga.** The hospital receives Internet service through a VSAT connection provided by Link Star for the past 3 years at a cost of $5,000/year. Beside wired connections to the dish, Dr. Williams mentioned to the team that the health information systems manager Guszt Nyanplu set up extension to the school of nursing with basic wifi routers were placed in key areas for the half dozen users including the Peace Corps volunteer and health program manager. During the visit, we tried to run the Speedtest.net test results at this site were (1284 ms ping, 0.15 Mb/s Up/ 0.03 Mb/s Down).

- **Visit to Cuttington University**. The university has approximately 2000 students with 6 colleges with a dedicated VSAT broadband connection. During our visit, we tested the current speeds of 384 Kb/s Down and 92 Kb/s Up with capacity of approximately 60 students connected concurrently with a current service agreement of $36,000/year. During the interview, the university staff considered the current serviced insufficient for online applications and would consider upgrading their current services (very expensive).

- **Visit to Kakata Rural Teacher Training Institute**. The RTTI serves a regional hub for education training for teacher education. At this site, the approximately 350 students enrolled have access to a computer laboratory with 24 computers powered by a stand-alone generator. The RTTI director expressed the need to have connectivity for distance education and online certification and testing. The computer laboratory will serve teacher-students in general computing and general software applications. Applications such as Wikipedia have been installed. Students could benefit from additional research capacity of online education journals and search engines, such as ERIC, GEM and other educator sites.

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