Communications of the Association for Information Systems

Volume 13 Article 38

June 2004

Global Diffusion of the Internet IV: The Internet in Ghana

William Foster
Arizona State University - West, wafoster@asu.edu

Seymour E. Goodman
Georgia Institute of Technology, goodman@cc.gatech.edu

Eric Osiakwan
Internet Research, eric.osiakwan@netplux.com

Adam Bernstein
Georgia Institute of Technology, bernstein@cc.gatech.edu

Communications of the Association for Information Systems

GLOBAL DIFFUSION OF THE INTERNET IV: THE INTERNET IN GHANA

William Foster
School of Management
Arizona State University – West
wafoster@asu.edu

Seymour Goodman
Sam Nunn School of International Affairs and College of Computing
Georgia Institute of Technology

Eric Osiakwan
ICT Consultant and Journalist
Internet Research, Ghana

Adam Bernstein
College of Computing
Georgia Institute of Technology

ABSTRACT

Ghana was one of the first countries in sub-Saharan Africa to gain Internet access. By 1996 it three Internet service providers (ISPs) were competing. During the Internet boom years, 1998-2000, the ISP and Internet Café industries in Ghana grew rapidly.

In 2004, policy-makers are struggling with the question of how to fund telecommunications deployment in rural Ghana. The question is urgent because use of Voice over IP (VoIP) technology for international voice calls ate away at Ghana Telecom's profits; profits the company says it desperately needs to fund deployment of a new telephone network.

We use the Global Diffusion of the Internet (GDI) framework to examine Internet diffusion in Ghana along six dimensions: Pervasiveness, Geographical Dispersion, Sectoral Absorption, Connectivity Infrastructure, Organizational Infrastructure, and Sophistication of Use. As shown by this analysis, Internet diffusion in Ghana did not evolved along these six dimensions since 2000. To reinvigorate Internet diffusion, we suggest that the Ghanaian government should allow some ISPs to operate in the rural VoIP and cellular markets on the condition that they invest their profits and use their expertise to build infrastructure in underserved areas. The Ghana ISP Association (GISPA) should take the lead in building a national backbone with Internet exchange.

Keywords: Internet diffusion, Ghana, ISP, Ghana Telecom, VOIP, GDI Framework, Mosaic

I. INTRODUCTION

The Internet is changing the costs of communicating significantly within Africa and between Africa and the rest of the world. The Internet is truly a world-wide phenomena. This study looks at the diffusion of the Internet in Ghana, one of the first countries in Africa with an Internet presence.

As in most countries, the complex relationship between the ISPs and the former PTT in a country impacts the pattern of Internet diffusion in that country.[1] By 1996, three commercial Internet Service Providers (ISPs), each with its own satellite connection to the global Internet, were competing in Ghana. These satellite connections allowed the ISPs to avoid using the existing telephone company, Ghana Telecom, for international connectivity. In many other African countries, in contrast, ISPs were required to access the global Internet through the Post, Telephone, and Telegraph (PTT), the incumbent telephone company. This arrangement allowed the PTT a bottleneck with which to control the ISP industry. Also, in many African countries the PTT offered ISP services to businesses, Internet cafés, and consumers. Ghana Telecom did not offer services that compete directly with ISPs.

Ghana's experience with the Internet offers insights into the potential for and limitations of the Internet in Africa. The Internet evolved earlier and further in Ghana than in most African countries, yet this evolution slowed since 2000.

The framework and methodology used for this study are described in Wolcott et al. [2001], This methodology has been used to study Internet diffusion in over 40 countries. An introduction to the framework is included as Appendix I. The authors used this framework to collect data from over 30 interviews with experts in government, academia, and business. The authors also interviewed users of the Internet who would not be considered experts. Additional data was collected from the World Wide Web.

After a short history of the Internet in Ghana (Section II), this study examines Internet diffusion in Ghana longitudinally along six dimensions (Section III). We then discuss factors that account for this pattern of diffusion by looking at a series of "determinants" (Section IV). These 13 determinants proved useful in our other national studies for understanding why the Internet came to be the way it is in a particular country. We conclude this study by suggesting ways the Ghanaian government can influence the evolution of the Internet in Ghana.

Table 1. Key Indicators for Ghana [World Fact Book, 2003]

Population (July 2003)	20,467,747
Literacy	74.8%
GDP (2002)	US$42.5 billion
Telephone (Main Lines) (2001)	240,000
Telephone (Main Lines) Per 100 (2001)	1.3
Telephone (Cellular) (2001)	150,000
Internet Users (2002)	200,000

[1] The impact of the relationship between ISPs and the PTT on the pattern of diffusion is documented in many of the case studies of the Global Diffusion of the Internet project. These cases can be viewed at http://mosaic.unomaha.edu/gdi.html.

Source: World Fact Book, 2003

Figure 1. Map of Ghana

II. HISTORY OF THE INTERNET IN GHANA

FIDONET

The first international computer network in Ghana was based on store and forward e-mail and bulletin board systems in which computers were linked through short dial-up calls. In 1989, a Fidonet connection was established between Greennet in London and the Ghana National Scientific and Technological Information Network (GHASTINET), the Association of African Universities (AAU), and the Technology Transfer Center (TTC) [Osiakwan, 2000]. The project started out as a pilot of the Pan African Development Information System (PADIS) and was funded by the Canada- based International Development Research Center (IDRC). The National Science and Technology Library and Information Center (NASTLIC) of the Center for Scientific and Industrial Research (CSIR) assumed responsibility for operating GHASTINET. Later, the Balme library at the University of Ghana became the central Fidonet hub for an extensive network that at its height supported 50,000 users [Osiakwan, 2000].

A few years, later a more robust store and forward e-mail system was built by AAU using the Unix to Unix Copy Protocol (UUCP), providing e-mail connectivity to twenty-three organizations, including the three major universities.

NETWORK COMPUTER SYSTEMS (NCS)

Though the AAU's e-mail system, AAUnet, allowed subscribers to route e-mail traffic to the global Internet, TCP/IP connectivity was first provided by a commercial system integrator, Network Computer Systems (NCS). NCS was started as a Digital Equipment Corporation (DEC) integrator by Dr. Nii Quaynor in 1988. Dr. Quaynor attended Dartmouth College and earned a

Ph.D. in computer science from the State University of New York at Stony Brook. He came back to Ghana on a sabbatical from DEC, where he was a senior software engineering manager.

In 1992, NCS applied to the Ministry of Transport and Communications for the right to offer value-added services such as e-mail. Originally, NCS was a user and reseller of MCI mail, but by 1994 NCS had established a 9600 bps Point to Point Protocol (PPP) connection over a dial-up link to Pipex, the largest ISP in England. NCS allowed its subscribers to dial-in to its computers, establish a shell account, and access the global Internet during the four to six hours a day when the connection to Pipex was up [Quaynor, 2003]. Dr. Quaynor applied for, and in January 1995 received, permission from Internet Assigned Number Authority (IANA) to use and administer the Ghana Domain name ".gh".

By August 1995, NCS purchased a 14.4 Kbps leased line from Ghana Telecom so that it could establish a dedicated TCP/IP connection with Pipex. NCS was then able to offer its clients World Wide Web (WWW), File Transfer Protocol (FTP), Telnet, and other Internet services on a 24/7 basis. By 1995, NCS had opened Points of Presence (POPs) in Kumasi and Takoradi. As the number of clients grew, NCS expanded its dedicated connection to Pipex to 64 Kbps [Quaynor, 2003].

In 1995, NCS also applied to the Frequency Board for permission to operate its own international gateway based on satellite technology. NCS received permission to operate a satellite connection and, in 1996, implemented a 3.8 meter class C satellite connection over which it was able to connect to the Internet backbone in the United States.

INTERNET GHANA

By June 1996, a second ISP, Internet Ghana, was up and running. It was established by Electromod, a local computer company run by Leslie Tamakloe. For international connectivity, Internet Ghana connected to the MCI Internet backbone in the United States via a 64Kbps dedicated connection leased from Ghana Telecom, running over Ghana Telecom's Nkuntunese 40 meter international earth station. Internet Ghana focused on developing corporate customers and worked with Ghana Telecom to provide access to customers via ISDN. Internet Ghana served approximately 20 corporate customers in 1996. The number of corporate customers grew to about 40 in 1998, 60 in 2000, and 84 in 2003 [Tamakloe, 2003]. The company focuses primarily on corporate clients, but does provide connectivity to CSIR and the Ministry of Health. Internet Ghana pioneered the use of DSL in Ghana and by 2003 was supporting approximately 150 subscribers on DSL over existing phone lines [Tamakloe, 2003]. These customers use a splitter to allow them to access both voice and DSL over the same line.

As the number of subscribers grew, Internet Ghana upgraded its connection to the Internet backbone to 256Kbps. By 2000, Internet Ghana was operating its own 2 Mbps satellite connection to the global backbone. In 2002, Internet Ghana purchased an additional 2 Mbps of connectivity through the SAT-3 submarine cable that runs from Portugal around South Africa to the Middle East [Tamakloe, 2003].

AFRICA ONLINE

Ghana's third ISP, Africa Online, was founded by three Kenyans who had studied at M.I.T. and Harvard and returned to Kenya to found an Internet service for all of Africa. The company received significant funding from Prodigy. In November 1996, Africa Online, led by Ghanaian M.I.T. alumnus Mawuli Tse, opened up service in Ghana using a 64Kbps Ghana Telecom leased line to its hub in Boston. After several months, this leased line was replaced with an earth station that provided 512 Kbps of international backbone connectivity. Africa Online also used VSAT to build a Ghana backbone of 2 Mbps that connected many of the regional capitals including Tamale. The dot com crash and the drying up of funds from Prodigy forced Africa Online to cut back many of its forays into the value added market. The company decided to focus on providing a high quality service sold at a premium [Sarpong, 2003].

THE PROLIFERATION OF ISPS

Between 1999 and 2003, Ghana's National Communications Authority (NCA) registered over 52 ISPs, of which 16 started operation (Table 2). The NCA gave many of the new ISPs licenses to operate their own international satellite gateways.

Table 2. ISPs in Ghana in 2003

ISP	Dial-up Subscriptions	Leased Line/Wireless	International Bandwidth
NCS	6,000	120	8 Mbps down/2 Mbps up
Africa On-line	3,000	105	3 Mbps
Internet Ghana	4,000	250	2 E1+2 Mbps (SAT-3)
IDN	4,000	200	1 E1
TIN-IFA	0	20	512 Kbps up/512 Kbps down
ITS	5,000	35	?
3rd Rail	0	50	3Mbps up/512 Kbps down
GS Telecom	0	70	1 E1
Natal	0	40	?
Nas Global	0	20	128 Kbps/128 Kbps
UBS Ghana	300	15	?
Africa Express	500	40	?
Afripa Telecom	0	25	?
Africanus	0	15	?
Total	~23,000	~1,000	~25 Mbps

INTERNET CAFÉS

Many ISPs focused on supplying Internet service to the many Internet cafés that sprung up in Accra. Over 1000 Internet cafés provide easy low cost access to the Internet for those without a PC, a phone line, or a subscription to an ISP. The biggest Internet café in Ghana is BusyInternet. Its over 100 PCs are connected to the Internet through its own satellite system. BusyInternet is the brainchild of Mark Davies, a naturalized American (originally from Wales). On BusyInternet's second floor is a business incubator that provides start-up Internet businesses with phone and high-speed Internet service. All of BusyInternet is backed by a US$30,000 generator and a huge battery to keep the computers running on battery power for 11 minutes until the generator kicks in. A US$18,000 transformer handles the frequent power surges [Zachary, 2003].

SATELLITE AND FIBER BACKBONES IN GHANA

Ghana's first IP over satellite connection was implemented by NCS using a PanAm satellite. The company now implementing the most satellite solutions is Ecoband (http://www.ecoband.net), which resells the Israel-based IP Planet satellite service [Sulzberger, 2003]. IP Planet uses the Intelsat, the global consortium owned by many of the world's PTTs. The traffic comes down at a Teleport operated by Veristar. IP Planet resells the satellite channel and all the routes needed to access the global Internet. IP Planet uses an asynchronous scheme in which downloads are done by using satellite Digital Video Broadcast (DVB). DVB technology, which puts IP packets in video frames, supports data speeds of up to 72 Mbps.

The IP over satellite market is evolving rapidly. Sulzberger [2003] of Ecoband estimates that an aggregate of 25 Mbps of international bandwidth is dedicated to IP currently being used in Ghana. Veristar and Intelsat are introducing IP services and bundling them with their satellite connection services. The competition between satellite providers is driving down the price of connecting to the global Internet.

Many of Ghana's ISPs and some of its Internet cafés provide satellite connections to the global backbone. Many ISPs are switching satellite services for connectivity. NCS, for example was using IP Planet with Teleglobe supplying the global IP connectivity, but switched to a service provided by Intelsat. Companies that buy their connectivity directly from Intelsat face problems in getting support.

Undersea cable now competes with satellite services in Ghana.[2] Ghana Telecom operates a landing point for the SAT-3 cable, which goes from Portugal around Africa. E1 (2 Mbps) connections to ISPs are available from Accra to Portugal for US$12,000 a month. The local loop connection in Accra is $500 a month. A one time charge of $2500 is imposed for a Cisco router [Sulzberger, 2003].

ISPs build out their networks within Ghana by providing access in some of the other regional capitals using a combination of VSAT, microwave, and fiberoptic connections for their backbone connectivity. An almost complete fiber optic ring links the regional capitals in the southern half of Ghana. The fiber is operated by Volta Communication (Voltacom) and owned by the Volta River Authority (VRA), which runs the hydroelectric plant on the Volta River and supplies electricity to much of Ghana. Although this fiber was intended to help manage the electrical grid, the plan was also to use it as a high speed data backbone for the country. Unfortunately, the government bureaucracy of the VRA is quite unresponsive and only a few ISPs (such as Third Rail and Internet Ghana) use its backbone capacities. The fiber, which uses Synchronous Digital Hiearchy (SDH), operates at 150 Mbps.

III. DIMENSIONS OF INTERNET DIFFUSION

Wolcott et al. [2001] provide a framework to describe Internet diffusion in a country. Named the Global Diffusion of the Internet (GDI) framework[3], it consists of six dimensions:

> *Pervasiveness:* A function of the number of users per capita.
>
> *Geographic Dispersion*: The physical dispersion of the Internet in a country.
>
> *Sectoral Absorption*: The commitment of organizations in the academic, commercial, health, and public sectors to Internet use.
>
> *Connectivity Infrastructure*: The extent and robustness of the physical structure of the network.
>
> *Organizational Infrastructure*: The robustness of the Internet services market.
>
> *Sophistication of Use:* How leading-edge groups of users are using the Internet.

PERVASIVENESS

The pervasiveness of the Internet in a country is a function of the number of users per capita. The Ghanaian government does not calculate statistics on the number of users in Ghana. Nua.com, which tracks estimates of users, cites the International Telecommunications Union (ITU)'s 2001 figure of 45,000 Internet users in Ghana in 2001 [Nua, 2003]. The World Fact Book estimates 200,000 Internet users in Ghana in 2002 [World Fact Book, 2003]. The major challenge in estimating the number of users in Ghana is estimating the average number of people

[2] Ecoband currently sells an E1 (2 Mbps) over satellite for about $14,000 a month plus a one time charge of $60,000 for the VSAT terminal. There is also a VSAT license fee of $4,000 [Sulzberger, 2003].

[3] The framework is summarized in Appendix I.

who share an Internet account and estimating the number of users who use an Internet café at least once a month. A panel of experts[4] developed Table 3 to justify the claim that between 1 in 100 and 1 in 10 Ghanaians use the Internet. They estimated that approximately 300,000 people in Ghana used the Internet at least once a month in 2003.

Table 3. Estimate of Users in 2003

Source	Number of Users
18,000 dial up accounts * 5 users per account	90,000
1000 leased lines * 20 users per LAN	20,000
Busy Internet	20,000
50 Large and Medium Internet Cafés * 1000 users	50,000
750 Small Internet Cafés * 100 users	75,000
Universities	40,000
Secondary Schools	?
TOTAL	~300,000

The panel of experts estimated that in 2001, when many of the new Internet cafés were started, the number of Internet users crossed the threshold of one Internet user among 100 people (Table 4).

Table 4. Pervasiveness in Ghana

1993	1994-1996	1997-1999	2000 –2003
Level 0	Level 1 (<1 in 1000)	Level 2 (> 1 in 1000)	Level 3 (>1 in 100)

One member of the expert panel believed that the number of users passed the threshold of one Internet user for every 10 people in Ghana. Ghana is clearly now at Level 3 (Established) for the Pervasiveness dimension (Table 5).

GEOGRAPHIC DISPERSION

The Geographic Dispersion dimension evaluates the physical dispersion of the Internet in a country. In many developing countries Internet access was initially available only in the capital city. Centralization is in part a legacy of the colonial system in which infrastructure investments were restricted to the capital city and a few key economic centers.

Table 5. The Pervasiveness of the Internet in Ghana in 2003

Level 0	*Non-existent*: The Internet does not exist in a viable form in this country. No computers with International IP connections are located within the country. There may be some Internet users in the country; however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1	*Embryonic*: The ratio of users per capita is on the order of magnitude of less than one in a thousand (less than 0.1%)
Level 2	*Nascent*: The ratio of Internet users per capita is on the order of magnitude of at least one in a hundred (.1% or greater).
Level 3	*Established*: The ratio of Internet users per capita is on the order of magnitude of at least one in a hundred (1% or greater)
Level 4	*Common*: The ratio of Internet users per capita is on the order of magnitude of at least one in ten (10% or greater)

[4] The panel of experts included Eric Osiakwan (Ghana ISP Association), Sy Goodman (MOSAIC Group), Will Foster (MOSAIC Group), Alexander Sulzberger (Ecoband), Gregg Pascal Zachary (International Computer Science Institute), and Clement Dzidonu (Chairman, National ICT Policy Committee).

In Ghana, the Internet was available relatively early for Africa in some of the economic centers. , NCS established a Point of Presence (POP) in Kumasi, a central commercial hub both for Ghana and West Africa by 1996. Internet Ghana and Africa Online soon followed suit. Five of the ten regional capitals now enjoy ISP Points of Presence (POPs) (Table 6).

Table 6. ISPs by City in 2003

City	Number of ISPs
Accra/Tema	25+
Cape Coast	2
Takoradi	3
Kumasi	4
Tamale	2

As part of its planned rollout in 2004-2005 of 400,000 new lines to all towns and villages that have a secondary school, Ghana Telecom committed to providing Internet access. If successfully implemented, this rollout will greatly increase the extent of geographic dispersion of the Internet in Ghana. At the same time, such a rollout by Ghana Telecom could undermine the incentive of the ISPs to roll out their services to the remaining capital cities and to rural areas. How Ghana Telecom balances being both a provider and a competitor to the ISP industry will strongly influence the evolution of the Internet services industry.

Table 7shows that Ghana is now at a Level 3 (Highly Dispersed) in geographic dispersion.

Table 7. Geographic Dispersion in 2003

Level 0	*Non-existent.* The Internet does not exist in a viable form in this country. No computers with International IP connections are located within the country. A country may be using UUCP connections for e-mail and USENET.
Level 1	*Single location*: Internet points-of-presence are confined to one major population center.
Level 2	*Moderately dispersed*: Internet points-of presence are located in multiple first-tier political subdivisions of the country.
Level 3	*Highly Dispersed*: Internet points-of-presence are located in at least 50% of the first-tier political subdivisions of the country.
Level 4	*Nationwide*: Internet points-of-presence are located in essentially all first-tier political subdivisions of the country. Rural access is publicly and commonly available.

Table 8 shows that Ghana reached Level 3 in 2000.

Table 8. Geographic Dispersion Across Time

1993	1994-1995	1996-1999	2000-2004
Level 0	Level 1	Level 2	Level 3

SECTORAL ABSORPTION

The Sectoral Absorption dimension measures the extent to which organizations in the academic, commercial, health and public sectors commit to Internet use. Because the GDI framework takes into account only IP connectivity, we did not include in our analysis the presence of store and forward e-mail systems in the Ghanaian academic community in 1993 and prior years. Measuring the sectoral absorption of Internet diffusion in Ghana in the academic sector and public sector in later years is complicated by the lack of institution-wide LANs at some institutions that can access leased lines for connectivity. For example, the Computer Science Department at the University of Ghana does not connect to the university's fiber optic backbone. The University of Ghana's backbone runs down only one side of the campus, so that departments such as the

Department of Agriculture cannot access the Internet. On the other hand, multiple Internet cafés provide Internet access to almost all students at the University of Ghana

Ghana is one of the nodes in the African Virtual University (AVU), a World Bank funded distance learning initiative that connects 22 universities in Africa with scholars in the West [Mbarika, 2003; Light, 1999]. For the past several years, the "Medium" ranking should apply to the academic and government sectors (Table 9).

Less clear is whether 10% or more of commercial organizations have their own Internet servers and whether the business sector should be evaluated at the Minimal or Moderate level. The small number of commercial domain names in Ghana is one sign that Internet adoption among businesses is low. Furthermore, Internet cafés lease a high percentage of the 1000 leased lines in Ghana. Many institutions are still using dial-up to access the Internet and do not lease lines for connectivity or to host their own servers. NCS hosts web pages for over 125 organizations. A list of these organizations is available on Ghana.com. Most of these sites are primarily static,not interactive web pages. We evaluate the business sector at the Minimal level.

Although not captured in the criteria for sectoral absorption, most Ghanaian Non-Governmental Organizations (NGOs) maintain their own web pages, though not necessarily their own servers.

In addition, although most health care organizations do not maintain dedicated connections to the Internet, the health care community used store and forward e-mail systems for quite some time. A number of projects involving the Internet in the health care field that are worth noting.

HealthNet (http://www.healthnet.org) links health workers in Ghana and around the world by e-mail. HealthNet uses a low-earth-orbit satellite to establish e-mail connectivity in various locations throughout Africa. In what is described as a major public health success story, African researchers used the network to track the presence of Black Fly (Simulium) larva, the vector of Onchocerciasis, along the Volta River.

The Mulilateral Initiative on Malaria Communication Network (MIMCom) allows African researchers studying malaria to send and receive mail, search medical literature and databases, and share files and images. Using VSAT terminals, MIMCom provides full Internet connectivity. The Ghanaian nodes for MIMCom are at the Noguchi Memorial Institute for Medical Research at the University of Ghana (http://www.noguchimedres.org) and the Navrongo Health Research Center (http://www.navrongo.org).

Table 9. Sectoral Use of the Internet in 2003

Sector	Minimal (1 point)	Medium (2 points)	Great Majority (3 points)
Academic	.0%-10% have leased line Internet connectivity	10%-90% have leased line Internet connectivity	90% have leased line Internet connectivity
Commercial	0%-10% have Internet Servers	10%-90% have Internet Servers	90% have Internet Servers
Health	0%-10% have leased line Internet connectivity	10%-90% have leased-line Internet connectivity	90% have leased-line Internet connectivity
Public	0%-10% have Internet servers	10%-90% have Internet servers	90% have Internet servers

Overall, we give Ghana a high Level 2 (Moderate) rating for sectoral absorption (Table 10)

Table 10. Sectoral Absorption of the Internet Scale

Sectoral point total	Sectoral Absorption	Dimension Rating
0	Level 0	Non-existent
1-3	Level 1	Rare
4-6	Level 2	Moderate
7-9	Level 3	Common
10-12	Level 4	Widely Used

Table 11 evaluates longitudinally sectoral absorption by sub-sector. Ghana clearly has been stuck in the Level 2 (Moderate) category since 1996. It is now at the high end of the Level 2 (Moderate) ranking. An improvement in the ranking of any one sub-sector will move the Sectoral Adoption ranking to Level 3 (Common).

Table 11. Sectoral Absorption Across Time

	1993	1994-1996	1996-2000	2001-2003
Academic	Non-existent	Minimal	Minimal	Medium
Governmental	Non-existent	Minimal	Minimal	Medium
Business	Non-existent	Minimal	Minimal	Minimal
Health	Non-existent	Non-existent	Minimal	Minimal
Sectoral Diffusion	Non-existent (Level 0)	Rare (Level 1)	Moderate (Level 2)	Moderate (Level 2)

CONNECTIVITY INFRASTRUCTURE

The Connectivity Infrastructure dimension evaluates the extent of the physical infrastructure of the Internet in a country. It is based on an evaluation of domestic backbone capacity, international connectivity, Internet exchanges, and local access methods.

The national backbones of the major ISPs in Ghana are primarily based on VSAT and wireless links. Total combined bandwidth for these backbones is beween10 and 100 Mbps. The aggregate domestic bandwidth of all the ISPs is at Level 2 (Expanded) (Table 12). Building a high speed national backbone at least in the southern regions using Voltacom's fiberoptic cable is possible. Unfortunately, Voltacom priced bandwidth over this fiber at a level that makes it uneconomical for ISPs to use. Ghana Telecom provides a national backbone but it is not sufficient to support the ISP industry.

Ghana international connectivity is approximately 25 Mbps, placing it at Level 2 (Expanded).

No Internet exchange connects the ISPs in Ghana. Traffic between the ISPs is now routed through the United States. Since the late 1990s, firms in the Internet industry discussed creating such an exchange. Africa Online offered to host the exchange as BusyInternet did later. The reality is that very little traffic goes between ISPs in Ghana (estimates are around 4%). Most Ghanaians access hosts outside Ghana, primarily in the United States. Even Ghanaians who send e-mail to other users in Ghana use the international services of Yahoo and Hotmail. Consequently, no economic incentive exists to implement an exchange. However, the dependency on international connectivity only perpetuates itself as Ghanaian companies place servers in the U.S. rather than in Ghana. Plans now are for GISPA to lead the establishment of the Ghana Internet exchange (GIX) at the Ghana Indian Kofi Annan Center of Excellence. This center benefits from being a neutral site. GIX should be working before the end of 2004.

Last mile access is distributed between dial-up access (often limited to 24Kbps), leased line connectivity (primarily 64Kbps), and wireless access. Internet Ghana successfully used DSL to connect companies. Although the pervasiveness of wireless and DSL access potentially justifies

a rating higher than Level 2 for Access Methods, the limited, low quality infrastructure justifies a Level 2 (Expanded) rating.

Table 12. Connectivity Infrastructure in 2003

		Domestic Backbone	International Links	Internet Exchanges	Access Methods
Level 0	Non-existent	None	None	None	None
Level 1	Thin	<=2 Mbps	<=128Kbps	None	Modem
Level 2	Expanded	2 Mbps- 200 Mbps	128 Kbps- 45Mbps	1	Modem 64 Kbps leased line
Level 3	Broad	200 Mbps – 100 Gbps	45 Mbps- 10 Gbps	More than 1; Bilateral or Open	Modem 64 Kbps leased lines
Level 4	Extensive	100 Gbps	10 Gbps	Many; both Bilateral and Open	<90% modem 64 Kbps leased lines

Table 13 shows that Ghana stayed in the Level 1 (Thin) range for Connectivity Infrastructure from 1996 through 2003, although it moved up half a point in 1997. Ghana's connectivity infrastructure when compared with most other countries at a Level 3 for Pervasiveness and Geographical Dispersion is clearly skewed on the downside.

Table 13. Connectivity Infrastructure over time

	1993	1994-1996	1997-1999	2000-2002	2003
Domestic	0	1	2	2	2
International	0	1	2	2	2
Internet Exchanges	0	0	0	0	0
Access	0	1	2	2	2
Aggregate	0	1	1.5	1.5	1.5

ORGANIZATIONAL INFRASTRUCTURE

The Organizational Infrastructure dimension evaluates the robustness of the Internet industry in a country. This dimension is based on the competitiveness of the market for Internet and basic telecommunications services. Ghana has been at a Level 3 (Competitive) in the organizational infrastructure dimension since 1996 (Table 14) when three ISPs were operating in Ghana. It should be noted that Ghana is one of the first countries in Africa to reach the Level 3 (Competitive) Level. Ghana, in our judgment, is not yet at Level 4 (Robust).

By 2003, 12 ISPs competed vigorously for both dial-up and leased line customers. ISPs can operate their own international gateways. Although the government authorized a second landline provider, competition in providing last mile access remains limited. For corporate customers and ISPs, wireless access provides an alternative to the high cost and low availability of leased lines. Even though competitive, the ISP market cannot be categorized as Level 4 (Robust). The lack of infrastructure, especially outside of Accra, greatly hampers the ISP industry. In addition, the lack of an exchange and interconnection agreements is a sign that the ISPs are not cooperating with one another or negotiating effectively with Ghana Telecom.

SOPHISTICATION OF USE

The Sophistication of Use dimension of the GDI framework evaluates the level of innovation associated with the Internet in a particular country. Ghana is clearly at Level 2 (Conventional) (Table 15). The Internet is used as an alternative to high priced international phone calls and a very inefficient postal system. Few signs point to societal processes or business processes being re-engineered to take advantage of the Internet. The lack of a credit card infrastructure and the

Table 14. Organizational Infrastructure in 2003

Level 0	*None*: The Internet is not present in this country
Level 1	*Single*: A single ISP has a monopoly in the Internet service provision market. The ISP is generally owned or significantly controlled by the government.
Level 2	*Controlled*: There are only a few ISPs and the market is closely controlled through high barriers to entry. All ISPs connect to the international Internet through a monopoly telecommunications service provider. The provision of domestic infrastructure is also a monopoly
Level 3	*Competitive*: The Internet market is competitive. There are many ISPs and low barriers to market entry. The provision of international links is a monopoly, but the provision of domestic infrastructure is open to competition, or visa versa.
Level 4	*Robust*: There is a rich service provision infrastructure. There are many ISPs and low barriers to market entry. International links and domestic infrastructure are open to competition. There are collaborative organizations and arrangements such as public exchanges, industry associations, and emergency response teams.

Table 15. Sophistication of Use in 2003

Level 0	*None*: The Internet is not used, except by a very small fraction of the population that logs into foreign services.
Level 1	*Minimal*: The user community struggles to employ the Internet in conventional, mainstream applications.
Level 2	*Conventional*: The user community changes established practices somewhat in response to or in order to accommodate the technology, but few established processes are changed dramatically. The Internet is used as a substitute or straightforward enhancement for an existing process (e.g. e-mail vs. post). This is the first level at which we can say that the Internet has taken hold in a country.
Level 3	*Transforming*: The use of the Internet by certain segments of users results in new applications, or significant changes in existing processes and practices, although these innovations may not necessarily stretch the boundaries of the technology's capabilities.
Level 4	*Innovating*: Segments of the user community are discriminating and highly demanding. These segments are regularly applying, or seeking to apply, the Internet in innovative ways that push the capabilities of the technology. They play a significant role in driving the state-of-the-art and have a mutually beneficial and synergistic relationship with developers.

lack of trust hindered the development of the financial infrastructure necessary to support business-to-consumer Internet services. Widespread fraud will undermine the deployment of that infrastructure for some time.

Although Ghana reached Level 2 (Conventional) by 1996, it did not yet move to a Level 3 (Transforming) rating in sophistication of use.

SUMMARY OF DIFFUSION RATINGS

Table 16 summarizes Ghana's Internet diffusion ratings in late 2003.

Table 16. Summary of dimensions in 2003

Dimension	Level	Comments
Pervasiveness	Level 3: Established	Approximately 300,000 users
Geographic Dispersion	Level 3: Highly Dispersed	POPs in 5 of 10 regions
Sectoral Absorption	Level 2: *Moderate*	Governmental and Academic organizations use some leased line connectivity. However, the entire campus is not connected. . Business use of servers is sparse.
Connectivity Infrastructure	Level 1.5: *Expanded*	Given level of infrastructure, lack of an exchange is noteworthy.
Organizational Infrastructure	Level 3: Competitive	ISPs can access to international connectivity through their own satellites, but must rely primarily on Ghana Telecom for land lines.
Sophistication of Use	Level 2: Conventional	Little re-engineering of business and social process to leverage the Internet.

As Table 17 shows, the evolution along the dimensions of the framework progressed rapidly at first but in 1999 began to stall. Ghana did not evolve since 2000. In many other countries outside of Africa, Internet diffusion scores continued to increase in the new Millennium. Policy makers in Ghana should be concerned about the country's lack of progress. What does Ghana need to do differently to reach higher levels of diffusion along each of the dimensions?

Table 17. Internet Dimension Rankings by Year.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pervasiveness	0	1	1	1	2	2	2	3	3	3	3
Geographical	0	1	1	2	2	2	2	3	3	3	3
Sectoral	0	1	1	2	2	2	2	3	3	3	3
Connectivity	0	1	1	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Organizational	0	1	1	3	3	3	3	3	3	3	3
Sophistication of	0	1	1	2	2	2	2	2	2	2	2

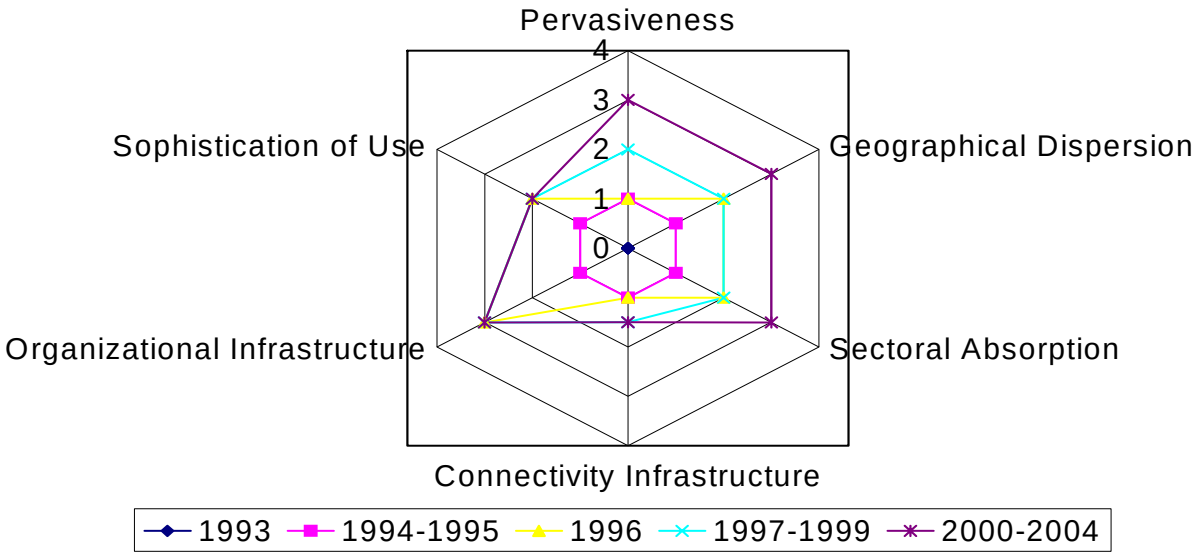

Figure 2. Internet Diffusion in Ghana

IV. DETERMINANTS OF INTERNET DIFFUSION IN GHANA

The determinants of Internet diffusion shape the evolution of the Internet over time. Identified in the course of conducting many GDI country studies, these determinants (Table 18) help explain the countries' movements along the Internet diffusion dimensions. An examination of these determinants can deepen our understanding of how the Internet evolved in Ghana and suggest policies that will encourage Internet growth there.

Table 18. Determinants of Internet Diffusion

Determinant	Description
Perceived Value	Advantages offered by Internet as compared to other existing communication options.
Ease of Use	How easy is the Internet to use for people in a country? This involves looking at literacy and availability of local language content.
Cost of Internet Access	How much does Internet cost relative to income levels?
technologies	Looks at the balance between all the technologies that must be present for various levels of use.
Demand for capacity, multiplicity of ISPS, services provided	How demand at various levels of the cluster is driving the connectivity infrastructure development.
Geography	How physical geography influences Internet development.
Adequacy and fluidity of resources	A broad category considering financial, informational, human, technological, or capital, and material resources and the ease with which they flow from where they are to where they are needed.
Ability to execute	The ability to develop a sound strategy and a suitable design given opportunities and constraints, and the ability to manage through to completion.
Culture of entrepreneurship	How entrepreneurship is rewarded, both at the organizational and individual level.
Regulatory/legal framework	Specific laws and regulations influencing Internet diffusion.
Forces for change	Such things as competitive environment, presence of demanding domestic customers, rate of creation of new organizations, presence of champions.
Enablers of change	Conditions that allow a community to accept and incorporate change, including institutional, historical, cultural, and educational factors.

Source: [Wolcott et al, 2001] p. 34

ACCESS TO THE INTERNET

Individual Access to the Internet

Individuals cannot use the Internet if they cannot access it. A barrier to Internet use in Ghana is a lack of PCs and telephones, both at home and at work. As a result, many individuals use Internet cafés. Internet cafés sprung up in some of the regional capitals, such as Kumasi, where there are ISPs. Many of these cafés started out as Tele-centers that provided telephone service to those who did not have a telephone. The quality of service differs significantly among different Internet cafés [Falch and Anyimady, 2003].

Internet cafés do not operate in most parts of Ghana, even in areas with telephone lines.. In most towns with telephone service, the only way to access the Internet is through a long distance call to an ISP in Accra or in one of the other regional capitals served by the Internet..

Ghana Telecom commited to roll out phone and Internet access over the next several years to every town and village in Ghana that contains a secondary school. If this promise is even partially realized, many more Ghanaians will be able to use the Internet. Ghana Telecom did not announce how it will implement Internet access in these towns or how it will leverage private sector investment to support ISPs and Internet cafés. It will use cellular technologies to support some of these remote sites [Sulzberger, 2003].

ISP Access to the Internet Backbone

In many countries, a national Internet backbone reduces the cost and difficulty of connecting ISPs to the global Internet. Since Ghana has no national Internet backbone, ISPs have to build their own national backbones to provide connectivity outside of Accra. For this reason, most of the major ISPs offer service in only three or four remote regional capitals.

As of July 2003, Ghana Telecom did not provide a national IP backbone to connect regional ISPs to one another and to the global Internet. The lack of a national backbone distinguishes Ghana from countries like Turkey, where the former PTT, Turk Telecom, provided backbone service to ISPs throughout the country [Wolcott and Goodman, 2000]. ISPs can obtain circuits from Ghana Telecom between regional capitals. ISPs supplement these circuits with their own VSAT networks to build their own IP backbones.

Because ISPs can get a license to operate their own international satellite gateways, access to the global Internet is competitive; Ghana Telecom is not a bottleneck on international connectivity. Ghana Telecom does provide ISPs and other organizations with high speed international access over the SAT-3 fiber optic cable that stretches around half of Africa. A SAT-3 connection costs US$12,000 a month. To connect to the global Internet, ISPs must lease, for an additional US$3000 a month, a second fiber connection from Portugal to a New York global Internet access point.

Market conditions force Ghanaian ISPs to pay for the full circuit to the global IP backbone. Some individuals, such as Dr. Quaynor, believe that this tarrif is unfair and that Ghanaian ISPs should only pay half the circuit cost because Ghanaian ISPs provide “routes” to Ghana for the global Internet carrier. Nevertheless, the competition and Intelsat’s recent entry into the Internet Protocol (IP) connectivity market are driving the cost of global connectivity down for Ghanaian ISPs. To sign customers, international telecommunications circuit providers are offering global IP connectivity for free or at a sharply discounted rate.

COST OF INTERNET ACCESS

The number of individuals who can afford to use the Internet is a function of the cost of Internet access. Initially prices for unlimited dial-up Internet service in Ghana were over US$100 a month. The prices since dropped substantially (to around US$25) with many options available to the consumer. Dial-up users must also pay Ghana Telecom a significant per minute charge for local

calls to ISPs; prices vary by location. Local calls are 200 Cedis (US$0.024) per minute in Accra and 400 Cedis (US$.047) per minute in Kumasi.[5]

Internet cafés offer connectivity for substantially less than even the cost of a local phone call. In Accra users can access a PC and a connection to the Internet for 5000 Cedis (US$0.59) per hour. At BusyInternet, known for its high speed Internet access, rates are 10,000 Cedis (US$1.17) per hour with discounts for use after midnight.

Organizations in Accra that want a dedicated connection to the Internet pay between US$500 and US$2000 per month to an ISP for a dedicated 64 Kbps connection plus US$500 to US$1000 per month to Ghana Telecom for a leased telephone line. Many ISPs allow users to circumvent the leased line charge by providing a wireless alternative, but wireless connections in Accra's business districts periodically experience interference from other wireless devices.

At locations where dial-up and leased lines are unavailable, users must be willing to pay for a satellite-phone or VSAT connection to an ISP in Accra or outside the country. In addition to the charges for satellite links and global IP connectivity, licensing fees are imposed.

EASE OF USE

All other factors being equal, technologies that are easy to use are more likely to be adopted than those that are difficult to use. Since most Ghanaians can read and write English and national literacy is 74.8% [World Fact Book, 2003], the Internet is relatively easy to use. Few websites serve indigenous languages such as Twi, the Ashanti language. One of these Twi websites was developed by Gideon Hayford Chonia at the University of Zurich who is trying to teach Twi on the Internet (http://www.unizh.ch/spw/afrling/ aliakan/index.html). Peace FM, a local station, broadcasts Twi over the Internet at www.peacefmonline.com.

Most of the Ghanaians in Accra frequenting Internet cafés do not seem to encounter difficulty accessing and using Yahoo e-mail and browsing websites. On the other hand, due to the weakness of the university system and the departure of many skilled workers from the country, very few people in Ghana are skilled and trained to construct new applications and protocols. Zachary [2003] in *Black Star* gives a good account of the few people and organizations that do.

Although not necessarily counted as Internet users, almost every Ghanaian is connected indirectly to the Internet through the many radio stations that often broadcast news obtained from the Internet.

PERCEIVED VALUE OF THE INTERNET

Ghanaians perceive the Internet as a way of communicating with friends, relatives, and organizations outside the country. In a study of 100 people at the BusyInternet Café in Accra, 27% chose e-mail as their most popular application (Table 19).[6]

[5] The price in US dollars is calculated using July 2003 exchange rate of 1 US dollar equal to 8333 Cedis.

[6] The BusyInternet survey was administered to 100 people who walked in the door to use a computer.

Table 19. Preferred Reason for Internet Use [BusyInternet, 2002]

Preferred reason for Internet Use	Percentage
E-mail	27%
Search	13%
Research	12%
Education	12%
Business	11%
Music	8%
News/Politics	8%
Web	6%
Games	2%
Chatting	1%
Sports	0%

Source: [BusyInternet, 2002]

Many BusyInternet clients spend their time doing e-mail and browsing (Table 20).

Table 20. Time Spent on E-mail [BusyInternet, 2002]

Percent of Time Spent on e-Mail	Percent of Users
0-25%	14%
25-50%	40%
50-75%	33%
75-100%	13%

Source: [BusyInterfnet, 2002]

In the survey, 49% of respondents said they primarily spend time communicating with family. Thirty percent of respondents said their e-mail contacts are primarily abroad; 22% claimed their contacts are in Africa. Of respondents' e-mail contacts outside of Africa, 60% are in the USA, 32% are in the UK, and the rest are from other parts of Europe [BusyInternet, 2002].

Eight percent of survey respondents said they use the headphone equipped PCs at BusyInternet to access music. Unlike Asian Internet cafés, few BusyInternet clients play games. Only 2% of the survey respondents said that games are their preferred application.

BusyInternet's clients appear to have a purpose in mind when using the web. Most customers (79%) always know what they want on the web and 19% sometimes do. Twenty-three percent of respondents claimed they use the web primarily for business, 23% claimed they use it for information, and 15% claimed they use the web for education. The most popular websites were Yahoo (41%) and Hotmail (22%) [BusyInternet, 2002[.

Nearly 3,000 people a week spend US$1.17 an hour to access the Internet at BusyInternet [Akofio-Sowah, 2003]. For many the connection speeds justify the cost, which is twice that of many Internet cafés.

The question remains how valuable Internet access is to citizens in rural areas. Internet evangelists in the development community often cite the potential of the Internet to provide rural farmers with more accurate and timely information on prices and conditions in regional and global agricultural markets. However, at present, few rural users access the Internet in Ghana.

Little business to business (B2B) and even less business to consumer (B2C) e-commerce takes place over the Internet in Ghana. In fact, BusyInternet blocks access to any secure website because its PCs repeatedly are used in attempts at fraud. Very few sites in Ghana are interactive. The breakdown of trust in cyberspace prevents resources from being invested in re-engineering businesses and social processes. Although some hold on to the prospect of the Internet facilitating commerce in de-monitarized economies, this hope is faint in Ghana.

ADEQUACY AND FLUIDITY OF RESOURCES

Capital is particularly expensive and hard to obtain in Ghana. Interest rates are currently over 30%. Quaynor built NCS through bootstrapping and reinvesting the cash flow generated by a successful ISP business. Africa On-Line was originally funded with venture capital from Prodigy and later needed to re-invent itself to cope with a post dot-com reality. Starting in about 1999, many entrepreneurs jumped into the Internet café and ISP markets. To finance their operations, a number of Ghanaian ISPs terminated international calls, even though the practice was banned by the NCA.

Not been enough resources in either the private or public sector are available to build a true national backbone. Much of the optical fiber was in place for a national backbone through the Volta River Authority. However, they overpriced for the market. This example underscores the inability of the Ghanian government to channel resources in a timely and effective manner.

LEGAL AND REGULATORY FRAMEWORK

A country's score on the Organizational Infrastructure dimension is strongly influenced by the legal and regulatory regime governing telecommunications. In the early 1990s, Ghana began to liberalize its telecommunications sector to spur economic development. Under the Accelerated Development Program (ADP), Ghana Telecom, was separated from the Ghana Post and Telecommunication Corporation and privatized. The Communication Act of 1996 (no. 524) created the National Communications Authority (NCA) as an independent regulator.

As the Internet emerged in the 1990s, policy-makers saw it as a value added service that used the basic telecommunications services of Ghana Telecom. In this regard, they used a distinction that had been adopted by GATT (General Agreement on Trade and Tariffs) and used by the World Bank and other development agencies pressing for reform of the telecommunications sector. Policy-makers agreed that value added services should be allowed to be offered by organizations that were separate from the former PTT, Ghana Telecom.

In 1995, NCS's President Nii Quaynor was able to convince the Frequency Board, the predecessor of NCA, that NCS should be licensed to run its own international satellite gateway connecting it to the global Internet. At the time, Ghana Telecom's international connectivity was a monopoly. However, in exchange for a payment to cover lost revenue, Ghana Telecom agreed to allow NCS to run a satellite gateway for its "value added" service.

Following the precedent established by NCS, the NCA gave Internet Ghana and Africa Online licenses to run their own international satellite gateways. Other potential ISPs began applying for licenses. Under pressure from the Ministry of Transportation and Communications to speed up the approval process for ISPs, the NCA dropped the requirement that ISPs needed licenses. The Ghanaian Communications Regulations of 2003 (L.I. 1719) specify that ISPs, which offer value added services, do not need a license but do need to register with the NCA.

Ghana Telecom was not pleased with some of the new ISPs. The firm complained to the NCA that some ISPs were violating the conditions of their "value added" status by accepting Voice over IP (VoIP) international calls over the ISP's international satellite connections and terminating the calls using the Ghana Telecom network. Ghana Telecom was adamant that it needed the revenue from international calls to fund its rollout of telecommunications infrastructure.

At this point, the Ghanaian government agreed that some VoIP traffic was permissible. A company could run VoIP software on its computers or on its PBX and then route the data traffic over the Internet to another company running VoIP software. What Ghana Telecom was so publicly incensed about was ISPs who took VoIP traffic that came in over the ISP's satellite gateway and routed it, for a fee, through Ghana Telecom's public switched network.

In response to Ghana Telecom's ire, a consultant hired by NCA in 2000 convinced the police to seize the equipment and arrest the managers of the three ISPs. The closure of the ISPs created

a wave of public outcry from the customers of those ISPs and from people who wanted to communicate with those customers. During the court hearing, NCA was unable to convince the Court that the ISPs were doing anything illegal. The equipment was returned and two of the three ISPs went back in business and recovered from the seizure.

Many new ISPs were created between 2000 and 2004 to arbitrage international VoIP calls. Some of these ISPs did not even register with NCA let alone get a license for an international satellite connection. NCA is imposing fines on these illegal operators.

Establishing Ghana's regulatory and legal framework for the Internet is contentious because of the VoIP issue. In encouraging the development of "value added" data services, the Ministry of Transportation and Communications did not foresee how quickly voice and data would converge. In spite of this contention, a healthy ISP industry emerged in Ghana.

ABILITY TO EXECUTE

An "ability to execute" refers to the ability to plan, execute, and complete projects expeditiously. The ability to execute influences the rate and extent of infrastructure build-out within a country. NCS, Internet Ghana, and Africa Online showed great ability to execute by building viable ISPs. Based on his extensive experience and contacts in business, government, and academia, Quaynor was able to negotiate for an international gateway in 1995. He was able to hire and train engineers to run NCS.

At the national level, Ghana's ability to execute is weaker. Ghana Telecom struggled to decide how to keep pace with the Internet phenomenon and all that it represents. It was not able to build a national Internet backbone, provide Internet exchange services, or even provide an adequate number of landlines. Its interconnections with the cellular carriers were a disaster. Although it spent a lot of money on Internet infrastructure, Ghana Telcom was not able to roll out a service by 2003. [Sulzberger, 2003].

Despite Quaynor's effectiveness in negotiating solutions with Ghana Telecom, NCA, Westel, and others, the ISP community developed some animosity towards him, and vice versa. An Ashanti saying is that "If I can't get ahead, I won't let you get ahead either." This state of affairs is represented by the image of an alligator with two heads, each trying to go in a different direction. This image is representative of what often happens in Ghana. Quaynor may feel more welcome and valued at the continental and global level than at the local level, as the Ghanaian ISP industry negotiates its relationship with NCA, Ghana Telecom and the Ghanaian government.

GEOGRAPHY

Countries with a large landmass, mountainous terrain, or widespread chains of islands face greater challenges building infrastructure than small and flat ones. Geography is not a factor limiting the diffusion of the Internet in Ghana. However, Ghana is still struggling to find the right economic and technical model for providing communication services to all of its citizens, particularly those in rural areas. Ghana telecommunications infrastructure is more developed in the south than it is in the less economically developed north. Although it was mismanaged, the Volta River Authority's fiber optic backbone runs through the south. VSAT and microwave service provide a way for Ghana Telecom and ISPs to connect with their POPs around the country.

DEMAND FOR CAPACITY AND CONNECTIVITY

Local demand for Internet capacity and connectivity helps create the "pull" conditions that encourage expansion of infrastructure, increases in infrastructure capacity, and emergence of new services and service providers. Clearly a capacity and connectivity are in demand in southern Ghana, particularly in Accra and, to a lesser extent, in Kumasi and some of the other regional capitals. Most traffic leaves the country. Ghanaians often use external portals such as

Yahoo to communicate among themselves. The need for an Internet exchange is not pressing in Ghana, but the lack of an exchange encourages Ghanaian businesses to host sites outside Ghana. And because sites are hosted outside the country, the demand for infrastructure within Ghana is less.

The demand for capacity and connectivity decreases further north in the country. If demand existed there, development of a national backbone and regional infrastructure would be much more likely. Without the infrastructure, the economies outside of Accra and Kumasi cannot develop; without the economies, infrastructure deployment languishes for want of demand for capacity and connectivity. It is a vicious circle.

CULTURE OF ENTREPRENEURSHIP

In many countries, much Internet expansion takes place as a result of entrepreneurial activity that leads to creating new organizations, new products and services, and efforts to promote them in the marketplace. A strong culture of entrepreneurship often provides a rich milieu in which innovation diffusion takes place.

Ghana's culture of entrepreneurship is significant, though not strong,. The first three ISPs were established by entrepreneurs. Once a business model is demonstrated successfully, it is copied repeatedly, as seen by the launching of many ISPs and Internet cafés in Ghana after 2000. However, Zachary [2003] claims that government instability in Ghana undermined entrepreneurial spirit by discouraging investment for the long term. Quaynor [2003] believes that Ghana needs both businesses that rely on Internet services, and entrepreneurs who can target market opportunities, take advantage of Ghana's resources, nurture its labor force, and invest resources wisely.

FORCES FOR CHANGE

The impetus for change in a country can come from many quarters such as a competitive environment, a cultural predisposition to change, or individuals who champion change,..In his book *The Internet Revolution and Developing Countries,* Wilson [2004] argues through case studies of Brazil, China, and Ghana that in each country the actions of a small group of people (whom Wilson labels "information revolutionaries") drove Internet diffusion. Quaynor is one of Wilson's Internet revolutionaries. The Minister for Communications and Transport, Edward Salia, is another. Salia fought his own Ministry to encourage privatization of value added services. Wilson also mentions Prof. Kissiedu and Prof. Dakubu at the University of Ghana, who developed Ghana's extensive store and forward e-mail system. Though not mentioned by Wilson, Leslie Tamakloe of Internet Ghana and Mawuli Tse, formerly of AfricaOnline, are also Internet revolutionaries.

These people are responsible for Ghana being one of the first sub-Saharan countries with not only one but three ISPs. Will these be the people help Ghana find a working balance between Ghana Telecom and other telecommunications providers such as ISPs and cell phone providers? Will new players emerge, such as David Gyewu who served in the President's office and who is now Deputy Minister of Communications and Technology? Will the ICT Policy Implementation Committee chaired by Clement Dzidonu build support for a national consensus? Have institutional forces become much more significant than individual information revolutionaries?

In Ghana, the growth of the Internet was also fueled by Ghanaians' curiosity for the outside world. Many are looking for a way out of the country. Ghanaians are willing to spend a significant part of their income to access the West via the Internet. The cash flow generated by individual and corporate subscribers financed the development of IP infrastructure at least in Accra.

Zachary's [2003] essay *Black Star* makes the point that if the Internet only serves to enable and encourage the best and the brightest to leave Ghana, it may be an enemy of development.

Zachary [2003] also provides a number of examples of talented Ghanaians who returned to Ghana with their technological expertise. For these individuals, the Internet is indispensable.

ENABLERS OF CHANGE

In certain countries, there are institutions that encourage innovations to flourish. An example would be a national system of innovation, perhaps based on the educational system. Though the Ghanaian educational system was a driver of store and forward email systems in the 1980s, it played a peripheral role in Internet deployment. Government can also be an enabler of change, though the government in Ghana had only a limited role in the diffusion of the Internet. Our inability to identify an enabler of change for Ghana points to the challenges faced by those who are trying to transform Ghanaian society to leverage the Internet.

V. CONCLUSION: GOVERNMENT POLICY AND THE DETERMINANTS OF INTERNET DIFFUSION

In all 40 countries the MOSAIC Group studied, government policy influences the determinants of Internet diffusion. Table 21 lists ways we believe the Ghanaian government can influence each of the determinants to increase Internet diffusion.

Table 21. Suggestions on How Ghana's Government Can Impact Determinants

Determinant	How Government can impact Determinant
Access to the Internet	
Individual Access to the Internet	Encourage investment in communications infrastructure throughout rural Ghana. Encourage rural Internet cafés.
ISP Access to the Internet	Support the Ghana ISP Association's efforts to build a national backbone and Internet exchanges.
Perceived Value of the Internet	Make available valuable services of government over the Web. Provide a legal regulatory and technical environment for financial transactions over the Internet.
Adequacy and Fluidity of Resources	Fund "demand" side activities.
Legal and Regulatory Framework	Allow ISPs that deploy infrastructure outside of Accra to be cellular carriers in those regions and to terminate VoIP calls. Allow negotiation between ISPs and Ghana Telecom on terminating VoIP calls.
Ability to Execute	Allow ISPs to be telecommunications providers.
Geography	Encourage infrastructure in Northern Ghana.
Demand for Capacity and Connectivity	Fund "demand" activities in rural areas.
Culture of Entrepreneurship	Expand number of university graduates on the theory that some will become entrepreneurs or work for them.
Forces for Change	Continue to allow Ghana's fascination with the West to drive funding of Internet infrastructure.
Enablers of Change	Create more university graduates. Be creative using national service requirements.

RECOMMENDATIONS TO THE GHANA GOVERNMENT

Based on our observations and analysis, we make the following recommendations to the government of Ghana:

1. The biggest challenge the government faces is how to finance the deployment of communications infrastructure given the deficit that Ghana Telecom faces. Zachary [2003] recommends that ISPs deploying infrastructure in rural areas be allowed to do VoIP. We recommend that ISPs should also be allowed to provide cellular service in regional areas where they build infrastructure.

2. The NCA should realize that making a distinction between basic telecommunications service and value added service is fundamentally flawed. The NCA should realize that ISPs are telecommunications service providers and IP can support voice and data. In addition, wireless technologies can now support IP traffic. The market, not NCA, should dictate which wireless technologies are deployed, whether they support and interconnect with IP, and how. Cell phones may become the preferred way of accessing the Internet in Africa.

3. The Ghanaian government should also realize that Ghana Telecom should face competition rather than be protected. The NCA should not try to pick technologies or even negotiate interconnection agreements. The argument for a natural monopoly is that duplicate services by competing providers will squander resources. Fortunately, global capital marketse learned their lessons about over-investing in telecommunications and investment capital is now hard to acquire. If telecommunications service providers grow primarily on the basis of their cash flow, investments will undoubtedly be made wisely. Ghana's ISPs should be given the opportunity to grow by re-investing their revenues and leveraging their experience from their Accra businesses to build out rural infrastructure. The Ghana ISP Association should take the lead in developing an Internet exchange in Ghana and should work with the World Bank to deploy a national backbone.

4. We believe Government funds are best invested in education. Ghana needs to pay its university professors with Internet skills at rates sufficient to attract and keep talented people. The government should consider what universities in Asia pay professors in the IT field and should fund research.

QUAYNOR'S RECOMMENDATIONS

Quaynor [2003] believes that the best hope for Ghana is to significantly increase the number of university graduates with technical degrees. All university graduates are required to spend a year after graduation in a national service position. The government, he argues, should place the best of these graduates at the cutting edge of technical and entrepreneurial ventures.

Quaynor's [2003] other idea about funding the development of businesses that will need communication technologies deserves further research and exploration. UNDP, the World Bank, the African Development Bank and other development agencies should fund research and pilot projects to explore the role of information technology and the evolution of global supply chains. Ghanaians must understand what is necessary to move up the value chain from being a producer of raw materials to being a value-added manufacturer of goods for both domestic consumption and export.

FINAL THOUGHTS

A strong and vibrant telecommunications industry provides relatively low-cost and high quality connectivity to businesses which need to communicate internationally. Ghana's head start in deploying the Internet gives it a competitive advantage over many other African countries by enabling Ghana- based businesses to compete in the global economy.

Ghana, like other countries, must be wary of the false hopes of technological utopianism. Although the Internet makes doing business in Africa easier, the level of corruption and fraud make it difficult. If Ghana can reduce these hurdles through the right combination of government leadership, market mechanisms, and technological innovations, then it will experience greater Internet diffusion as measured by the GDI framework.[7] In doing so, Ghana may build a valuable "gateway" to Africa.

---

[7] Wolcott et al., (2001) suggest that progress up the scales of the dimensions reflects an evolutionary movement in Internet diffusion.

ACKNOWLEGEMENTS

The authors thank Dr. Mike Best of MIT and Dr. Wes Shrum of Louisiana State University for their helpful comments on the draft of this manuscript. All omissions and errors are the responsibility of the authors.

Editor's Note: The article was fully refereed. This article was received on November 21, 2003. It was with the author for twelve weeks for 2 revisions. It was published on June 30, 2004

REFERENCES

EDITOR'S NOTE: The following reference list (and the text) contains the address of World Wide Web pages. Readers who have the ability to access the Web directly from their computer or are reading the paper on the Web, can gain direct access to these references. Readers are warned, however, that

1. these links existed as of the date of publication but are not guaranteed to be working thereafter.

2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.

3. the authors of the Web pages, not CAIS, are responsible for the accuracy of their content.

4. the author of this article, not CAIS, is responsible for the accuracy of the URL and version information.

Akofio-Sowah, E. (July 2003), Personal Communication

BusyInternet (2002) "Survey on Why PeopleUse the Internet", Busy Internet Publications

Coomson, J. (2003) "32 ISPs caught in NCA dragnet," *The Ghanaian Chronicle*, Oct. 1

Faich, M. and A. Anyimadu (2003) "Tele-Centers as a Way of Achieving Universal Access—The Case of Ghana," *Telecommunications Policy*, (27)1, pp. 21-39

Goodman, S. et al. (1998) *The Global Diffusion of the Internet Project: An Initial Inductive Study,* The MOSAIC Group, Fairfax, VA, http://mosaic.unomaha.edu/GDI1998/GDI1998.html (current October 2, 2003)

Gyewu, D. (July 2003), Personal Communication

Liff, S., J. He, and F. Steward (1993) "Technology Content and Competitive Advantage: Strategic Analysis in the Steel Processing and Watch Manufacturing Sectors in the People's Republic of China," *Int. J. Technology Management*, Vol. 8, No. 3-5, pp. 309-332

Light, D. A. (1999) "Pioneering Distance Education in Africa," *Harvard Business Review*, (77)5 p. 26

Mbarika, V. (2003) "TeleEducation in Sub-Saharan Africa: A Breakout Approach to Sub-Saharan Africa's Education Dilemma", *IEEE Technology and Society*, (22)4, pp. 20-26

Nua (2004) "How Many Online?" http://www.nua.com/surveys/how_many_online_/africa.html (current May 16, 2004)

Osiakwan, E (2000) *Ghana's Internet Industry,* Self-published

Quaynor, N. (July 2003), Personal Communication

Sarpong, A. (July 2003), Personal Communication

Sulzberger, A. (July 2003), Personal Communication

World Fact Book, "Ghana", http://www.cia.gov/cia/publications/factbook/geos/ gh.html last updated August 1, 2003 (current September 20, 20003)

Tamakole, L. (July 2003), Personal Communication

Technology Atlas Team (1989) A Framework for Technology-Based Development: Technology Content Assessment, ESCAP, New York: United Nations

Wolcott, P and S. Goodman (2000) *The Internet in Turkey and Pakistan: A Comparative Analysis*", Center for International Security and Cooperation (CISAC), Stanford, CA: Stanford University, http://mosaic.unomaha.edu/TurkPak_2000.pdf (current October 2' 2003).

Wolcott, Peter, Larry Press, William McHenry, Seymour E Goodman, William Foster (2001) "A Framework for Assessing the Global Diffusion of the Internet", *Journal of the AIS*, November, (2)6 http://jais.isworld.org/ articles/default.asp?vol=2&art=6 (current March 1, 2003).

Wolcott, P., S. Goodman, G. Burkhart (1997) *The Information Technology Capability of Nations: A Framework for Analysis*, MOSAIC Group Report, http://mosaic.unomaha.edu/ITC_1996.pdf (current October, 2, 2003)

Wilson, E. (2004) The Internet Revolution and Developing Countries,Cambridge, MA: MIT Press,

Zachary, G. P. (2003) *Black Star*, Center for Science, Policy and Outcomes, www.cspo.org/products/articles/Blackstar.pdf (current October 2, 2003)

APPENDIX I. GLOBAL DIFFUSION OF THE INTERNET FRAMEWORK

The analytic framework used here is laid out in "A Framework for Assessing the Global Diffusion of the Internet"[Wolcott et al., 2001], available at http://jais.isworld.org/articles/ default.asp?vol=2&art=6. The framework was initially formulated in *The Global Diffusion of the Internet: An Initial Inductive Study* [Goodman et al, 1998], based on a more general analytic framework developed in *The Information Technology Capability of Nations* [Wolcott, 1997]. The framework consists of dimensions and determinants. Dimensions are six variables, described below, that capture the state of the Internet within a country at a given point in time. Determinants reflect the factors that led to the observed state and will likely influence future development.

A useful analytic framework should be sufficiently rich that it captures the multifaceted diversity of countries' experiences with the Internet. At the same time, the number of variables should be small enough that they can be easily kept in mind. Each of the variables should describe an important, somewhat intuitive, and measurable feature of the presence of the Internet in a country. In a rough sense, the variables should form a complete set in that they collectively cover almost everything that might reasonably be of interest, and each variable should have something to offer to the overall picture that the others do not. Finally, for the framework to be useful, it must be feasible to measure the values of the variables given a modest investment of resources. If the analytic framework is based on variables that cannot be measured in practice, then its effectiveness is compromised.

The six dimensions of Internet Diffusion are shown in Table A-1.

Table A-1. Dimensions of the Diffusion of the Internet

Dimension	Description
Pervasiveness	Number of users per capita
Geographic Dispersion	Physical dispersion of infrastructure and access; primarily a function of the fraction of first-tier political subdivisions (states, provinces, governorates, etc.) with Internet points of presence (POPs).
Sectoral Absorption	Extent of connectivity in four social sectors: Education, Commercial, Health, and Government.
Connectivity Infrastructure	Capacity of the technical infrastructure; primarily a function of the capacity of domestic and international backbones, and the types of access (e.g. modem vs. high-speed) available to users.
Organizational Infrastructure	Internet services market characteristics; a measure of the richness, robustness, and level of choice of the Internet service provision market.
Sophistication of Use	Integration, transformation, and innovation; a measure of the nature of Internet usage by a leading segment of the user community.

The Internet within a particular country at a particular point in time may be assigned one of five levels along each dimension. A dimension/level approach was also employed by the United Nations Economic and Social Commission for Asia and the Pacific in its Technology Atlas Project [Technology Atlas Team, 1989].

Table A-2 illustrates distinctive features, common to all dimensions, of the levels. The levels should progress from less to more in an ordered way. Using an order of magnitude difference between levels provides a number of advantages.

1. It increases the probability that two observers looking at the same country at the same point in time are likely to come up with the same assignments of levels, despite data about the Internet often changing rapidly, being incomplete, and of variable credibility.

2. While the measure is fundamentally quantitative, levels include a qualitative aspect. When a country progresses from one level to another, the change is substantial enough that it is likely to observe a significant change in the impact and use of the Internet on a country.

Table A-2. The Pervasiveness of the Internet

Level 0	*Non-existent*: The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country. There may be some Internet users in the country; however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1	*Embryonic*: The ratio of users per capita is on the order of magnitude of less than one in a thousand (less than 0.1%).
Level 2	*Established*: The ratio of Internet users per capita is on the order of magnitude of at least one in a thousand (0.1% or greater).
Level 3	*Common*: The ratio of Internet users per capita is on the order of magnitude of at least one in a hundred (1% or greater).
Level 4	*Pervasive*: The Internet is pervasive. The ratio of Internet users per capita is on the order of magnitude of at least one in 10 (10% or greater).

While the "state" of the Internet at a given point in time within a given country can be captured using the dimensions outlined above, it is perhaps more important to understand the factors that caused the Internet to evolve to the state it has. Figure A-1 shows the collection of top-level factors that most strongly shape the nature and extent of the Internet within a country. Government policies are identified separately as a determinant because of their importance and because government policies usually impact the dimensions only indirectly, by shaping other

determinants. The arrows reflect the direction of influence between the independent variables (determinants) and the dependent variables (dimensions) used in this study. We do not imply that other influences do not exist. For example, government policy makers may formulate policies in part as a reaction to the state of the Internet itself.

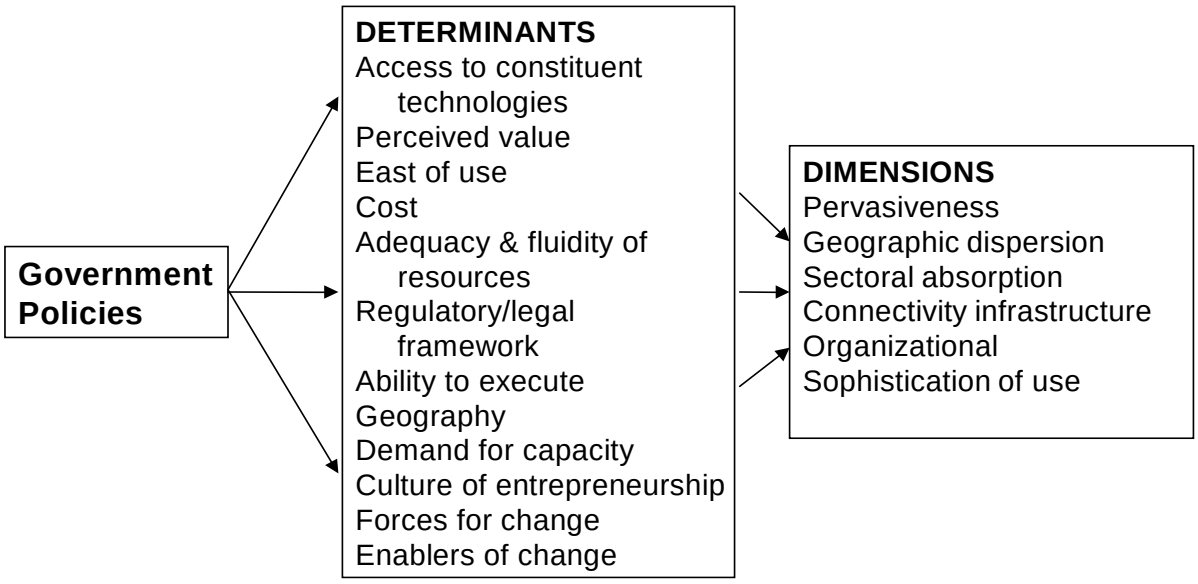

Figure A-1. Determinants of Internet Diffusion

Not all determinants impact all dimensions strongly. For example, Pervasiveness is primarily a function of access to constituent technologies, perceived value, ease of use, and cost. If any of these factors is highly unfavorable, then individuals will not access the Internet, even if the other three factors are favorable. Identification of the subset of determinants most directly influencing particular dimensions can yield suggestions for policies that can promote (or hinder) development of that dimension.

In summary, the analytic framework employed in the Global Diffusion of the Internet Project captures the state of the Internet within a country in a rich, multifaceted, yet relatively straight-forward way through the use of dimensions. The determinants provide insight into factors shaping the Internet's evolution. Together, the dimensions and determinants provide an analytic tool that is helpful for conducting longitudinal studies and multi-country comparisons, and formulating policy recommendations.

ABOUT THE AUTHORS

William Foster is Assistant Professor in the School of Management at Arizona State University West. He wrote his Ph.D. dissertation at the University of Arizona on the Diffusion of the Internet in China. His publications appear in*The Communications of the ACM, The Journal of the Association of Information Systems (JAIS), and Information Technologies and International Development.*

Seymour (Sy) Goodman is Professor of International Affairs and Computing, jointly at the Sam Nunn School of International Affairs and the College of Computing at the Georgia Institute of

Technology. He serves as Co-Director of both the Georgia Tech Information Security Center (GTISC) and the Center for International Strategy, Technology and Policy (CISTP). Prof. Goodman's research interests include international developments in information technologies (IT), technology diffusion, IT and national security, and related public policy issues.

Eric M.K Osiakwan is an ICT consultant and journalist and runs Internet Research, a firm located in Accra, Ghana. He is also the Executive Secretary of the African Internet Service Providers Association (AfrISPA, http://www.afrispa.org) and can reached at eric.osiakwan@netplux.com.

Adam Bernstein is a doctoral student in the College of Computing at the Georgia Institute of Technology.

Communications of the Association for Information Systems

ISSN: 1529-3181