
WIMAX IN AFRICA: A NEW FRONTIER

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*“Technology is not neutral, neither economically, nor pedagogically.”*¹

I. INTRODUCTION

The struggle to bridge the digital divide has endured in many African nations for decades.² The most impeding factors oftentimes depend on whether some of the most basic elements necessary for a telecommunications infrastructure are intact. Africa has the lowest concentration of telephone lines in the world as well as the fewest Internet users.³ The landline infrastructures that do exist largely have deteriorated due to inadequate

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¹ U.N. Conference on Trade & Dev., Div. for Serv. Infrastructure Dev. & Trade Efficiency, *E-Commerce and Development Report 2004*, 113, U.N. Doc.UNCTAD/SDTE/ECB/2004/1 (Dec. 15, 2004) [hereinafter *E-Commerce and Development Report*], available at http://www.unctad.org/en/docs/ecdr2004_en.pdf.

² The digital divide refers to the uneven spread of the Internet. Although oftentimes referring to the gap that exists between developed and developing countries, a digital divide can also exist between urban and rural areas as well as across varying economic and social groups in one country regardless of whether it is a developing or developed country. See generally Mauro F. Guillen & Sandra L. Suarez, *Explaining the Global Digital Divide: Economic, Political and Sociological Drivers of Cross-National Internet Use*, 84 SOC. FORCES 681, 681 (Dec. 2005); U.N. Conference On Trade & Dev., *The Digital Divide Report: ICT Diffusion Index 2005*, U.N. Doc. UNCTAD/ITE/IPC/2006/5 (2006) [hereinafter *The Digital Divide Report*], available at http://www.unctad.org/en/docs/iteipc20065_en.pdf.

³ U.N. ECON. COMM’N FOR AFRICA, ECONOMIC REPORT ON AFRICA 2005: MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA 252 (2005) [hereinafter *MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA*], available at <http://www.uneca.org/era2005/full.pdf>.

funding, maintenance and repair.⁴ Sections of telecommunications infrastructures in many nations have been damaged beyond repair due to internal conflicts or wars.⁵ Furthermore, transporting equipment to construct or repair telecommunications infrastructures or to transport any imports or exports, in general, is not only arduous but also time consuming.⁶ Shipments are often delayed in land-locked nations, aggravated by customs delays and legal and illegal checkpoints.⁷ Moreover, African governments have other pressing concerns that often take priority over telecommunications issues. “[L]ow productivity, low GDP growth rates, increases in total unemployment, stagnation in employment-to-population ratios and working poverty” are obstinate setbacks that have burdened the region for decades.⁸ Thus, the drive and incentive to reform telecommunications construction and regulations have in large part stalled.

For many African nations, however, constructing telecommunications infrastructures and expanding deployment of communications services are necessary steps to improve business, commerce, investment, and trade. The lack of telephone lines, for example, constrains local business operation and expansion. Potential financial opportunities that are lost due to a lack of basic infrastructure can have a negative causal effect on a local or even national level, encumbering private sector development.⁹ Granted, improving the telecommunications sector or increasing access to Information and Communications Technologies (“ICTs”)¹⁰ will not jumpstart an entire national economy. They are but one of many factors needed for economic

⁴ ROY STEINER ET AL., THE INT’L DEV. RESEARCH CTR., PROMOTING AFRICAN RESEARCH AND EDUCATION NETWORKING x (2005), *available at* http://www.idrc.ca/uploads/user-S/11247187481PAREN_Report_final.pdf.

⁵ *See id.*

⁶ *See* U.N. ECON. COMM’N FOR AFRICA, ECONOMIC REPORT ON AFRICA 2006: CAPITAL FLOWS AND DEVELOPMENT FINANCING IN AFRICA 139 (2006) [hereinafter CAPITAL FLOWS AND DEVELOPMENT FINANCING IN AFRICA], *available at* http://www.uneca.org/eca_resources/Publications/books/era2006/full.pdf.

⁷ *Id.*

⁸ INT’L LABOUR ORG., WORLD EMPLOYMENT REPORT 2004-05 60 (2005), *available at* <http://www.ilo.org/public/english/employment/strat/wer2004.htm> [hereinafter WORLD EMPLOYMENT REPORT].

⁹ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 252.

¹⁰ Information and Communications Technologies (“ICTs”) refers to the “hardware, software, networks, and media for the collection, storage, processing, transmission and presentation of information (voice, data, text, images), as well as related services. World Bank, *Information and Communications Technologies – ICT Glossary Guide*, <http://www.worldbank.org/ict> (follow “ICT Glossary” hyperlink in “ICT Resources” box) (last visited Mar. 26, 2007). Information Technology (“IT”) refers to “the hardware and software of information collection, storage, processing, and presentation.” *Id.* *See generally* Dale W. Jorgenson, *Information Technology and the U.S. Economy*, 91 THE AM. ECON. REV. 1 (2001) (detailing a thorough history of the development of IT in the United States within the context of the role and impact IT has had within America’s economic growth during the 1990s).

development. However, they do provide significant means to achieve a broader goal.

Wireless technologies and networks have become indispensable for governments, businesses, and individuals in many developing nations to circumvent the considerable expenditures required to install new, or connect to existing albeit outdated, traditional telecommunications infrastructure.¹¹ A nascent wireless technology, World Interoperability for Microwave Access (“WiMAX”), promises enhanced wireless network capabilities that could accelerate what existing wireless technologies have already been accomplishing for many developing nations with limited infrastructures and financial means.¹² This Comment will explore WiMAX and the potential impact it may have in developing nations, with a specific focus on sub-Saharan Africa. Development of national telecommunications infrastructures and deployment of ICTs, including WiMAX, are crucial to meeting the most important challenge facing many sub-Saharan African and other developing nations: economic development.¹³

This Comment is divided into five main parts. Part II introduces WiMAX, exploring the technological features and capabilities underpinning its potential for success in developed and developing nations alike. This

¹¹ Any wireless access network may eventually connect to a wired access network. Kevin C. Kahn, *On Spectrums and Standards, Architecture and Access Points*, in THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES 11 (Wireless Internet Institute ed., 2003), available at <http://www.infodev.org/en/Publication.24.html> (follow “Download Now” hyperlink). Thus while wireless systems can vastly reduce the need for wired networks, they will not fully replace the need to establish wired networks in most countries. *See id.*

¹² WiMAX’s expanded coverage has been seen as crucial in expanding the way wireless technologies has traditionally been used, such as how businesses expand by engaging in online business transactions and e-Commerce, how universities reach students in remote areas unable to afford or travel to a higher educational institution, or how health institutions provide medical advice on hygiene and certain diseases or provide health insurance to more individuals. *See generally* Rahul Tongia, *Connectivity and the Digital Divide – Technology, Policy, and Design tradeoffs for Developing Regions*, Presented at 34th TPRC (2006), available at <http://web.si.umich.edu/tprc/papers/2006/512/ConnectivityDigitalDivide.pdf>; GUY CAYLA ET AL., WIMAX FORUM, WIMAX: AN EFFICIENT TOOL TO BRIDGE THE DIGITAL DIVIDE, (Nov. 2005), available at http://www.wimaxforum.org/news/downloads/WiMAX_to_Bridge_the_Digitaldivide.pdf.

¹³ Establishing a telecommunications infrastructure or increasing access to the Internet or ICTs does not automatically guarantee economic development. *See* U.N. Conference on Trade & Dev., *Information Economy Report 2006*, 45–52, U.N. Doc.UNCTAD/SDTE/ECT/2006/1 (2006), available at http://www.unctad.org/en/docs/sdteecb20061_en.pdf [hereinafter *Information Economy Report 2006*]. Nevertheless, many nations continue to actively pursue policies and initiatives to integrate ICTs to be effectively utilized to foster long-term development. The value sought in connecting new users lies not only in the information that can be obtained but in the potential and broader opportunities provided for international trade, employment, education, and research. *See* Peter Cukor & Lee McKnight, *Knowledge Networks, the Internet, and Development*, 25-WTR FLETCHER F. WORLD AFF. 43 (2001).

Comment does not attempt to predict WiMAX's future or success. WiMAX access in the United States is currently limited and attempts to roll out nationwide wireless WiMAX networks will not occur until 2008. In the meantime, telecommunications companies from the United States and abroad are bringing WiMAX to some of their bigger clientele in developing nations.

Part III explores the reasons why African and developing nations are driven to pursue advanced ICTs, even as they grapple with ongoing concerns of poverty and unemployment. The correlation between information technology and economic development has been acknowledged by international organizations including the United Nations, the World Bank, and the Organization of Economic Co-operation and Development. Part IV looks specifically at the challenges faced by nations in sub-Saharan Africa in obtaining access to ICTs.

Part V addresses the potential impact of WiMAX in the sub-Saharan region. Although WiMAX is only beginning to emerge and few success stories can be cited, the combined forces of necessity and technological innovation foretell that WiMAX will be adopted and adapted in varying degrees across the region. The hope in many developing nations is that wireless technologies like WiMAX will open the door to greater technology and communications access, and a better way of life for those in the developing world.

II. WIMAX: "THE JEWEL OF THE CROWN"¹⁴

A. Exploration of WiMAX Technology

WiMAX is a wireless network technology designed and certified for interoperability on the Institute of Electrical and Electronics Engineer's ("IEEE") 802.16 standard.¹⁵ WiMAX provides wireless broadband connectivity¹⁶ for virtually any broadband user situation: fixed, portable, nomadic,

¹⁴ Ben Ames, *New Intel Mobile Platform Slated for First-Half of 2007*, INFOWORLD DAILY NEWS ONLINE, Sept. 27, 2006,

http://www.infoworld.com/article/06/09/27/HNintelmobile_1.html (quoting Dadi Perlmutter, senior vice president and general manager of Intel).

¹⁵ IEEE, About the IEEE, <http://www.ieee.org/web/aboutus/home/index.html> (last visited Mar. 26, 2007). Standards set by the Institute of Electrical and Electronics Engineers ("IEEE") are universally recognized standards. *Id.* The IEEE, a non-profit organization, is "one of the world's leading professional associations for the advancement of technology." *Id.* The IEEE plays a significant role in "standardization in both traditional and emerging fields, particularly telecommunications, information technology, and power generation." IEEE, IEEE Standards, <http://www.ieee.org/web/standards/home/index.html> (last visited Mar. 26, 2007).

¹⁶ Wireless broadband, which can be fixed or mobile, connects a user to the Internet by "a radio link between the customer's location and the service provider's facility." FED.

and mobile.¹⁷ It offers “last mile wireless broadband access as an alternative to cable¹⁸ or DSL [otherwise known as Digital Subscriber Line].”¹⁹ WiMAX is suitable for longer distance and outdoor networking as well as for shorter range wireless local area networks (“WLANs”) and wireless personal area networks.²⁰ From the start, WiMAX was designed for Wireless Metropolitan Area Networks (“WMAN”) service to provide service to more users. WiMAX’s speed is faster than cellular broadband technologies that are currently deployed²¹ and thus offers faster data rates.²² WiMAX also provides broader coverage.²³ Whereas the more widely deployed wireless technology Wireless Fidelity (“Wi-Fi”), which operates within the

COMM’NS COMM’N, FCC CONSUMER FACTS, HIGH-SPEED INTERNET ACCESS—“BROADBAND” 3 Mar. 15, 2006 [hereinafter HIGH-SPEED INTERNET ACCESS—“BROADBAND”], available at <http://www.fcc.gov/cgb/consumerfacts/highspeedinternet.pdf>. “The Federal Communications Commission [“FCC”] generally defines broadband service as data transmission speeds exceeding 200 kilobits per second (Kbps), or 200,000 bits per second, in at least one direction: downstream (from the Internet to your computer) or upstream (from your computer to the Internet).” *Id.* at 1. “Broadband includes several high-speed transmission technologies,” including Digital Subscriber Line (“DSL”), cable modem, fiber, wireless, satellite, and Broadband over Powerline (“BPL”). *Id.*

¹⁷ SENZA FILI CONSULTING, THE WiMAX FORUM, FIXED, NOMADIC, PORTABLE AND MOBILE APPLICATIONS FOR 802.16-2004 AND 802.16e WiMAX NETWORKS 3 (2005) [hereinafter FIXED, NOMADIC, PORTABLE AND MOBILE APPLICATIONS FOR 802.16-2004 AND 802.16e WiMAX NETWORKS], available at http://www.wimaxforum.org/technology/downloads/Applications_for_802.16-2004_and_802.16e_WiMAX_networks_final.pdf.

¹⁸ “Cable modem service enables cable operators to provide broadband using the same coaxial cables that deliver pictures and sound to [the subscriber’s television] . . . by turning on their computers without dialing-up an ISP” while simultaneously watching cable television. HIGH-SPEED INTERNET ACCESS—“BROADBAND”, *supra* note 16, at 2. Although speeds vary depending on the traffic, modem, and network, they “are comparable to DSL.” *Id.*

¹⁹ WiMAX Forum, Frequently Asked Questions, <http://www.wimaxforum.org/technology/faq/> (last visited Mar. 26, 2007). DSL “is a wire-line transmission technology that transmits data faster over traditional copper telephone lines already installed to homes and businesses.” HIGH-SPEED INTERNET ACCESS—“BROADBAND”, *supra* note 18, at 2. In addition, “DSL-based broadband provides transmission speeds ranging from several hundred Kbps to millions of bits per second (Mbps).” *Id.*

²⁰ FED. COMM’NS COMM’N, WIRELESS BROADBAND TASK FORCE REPORT 17 (2005), http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-257247A1.pdf [hereinafter WIRELESS BROADBAND TASK FORCE REPORT]. Wireless personal area networks (“WPANs”) have a range of shorter than ten meters. *Id.* Wireless local area networks (“WLANs”) comprise of individual network links spanning up to three miles. *Id.*

²¹ Jennifer Farwell, *Sprint Nextel Embraces WiMAX: What It Means for You*, PCTODAY, Feb. 2007, at 28, available at <http://www.pctoday.com/Editorial/article.asp?article=articles/2007/t0502/06t02/06t02.asp&guid=>.

²² Intel, Inc., *Understanding Wi-Fi and WiMAX as Metro-Access Solutions* 11 (white paper, 2004) [hereinafter *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*], available at <http://www.intel.com/netcomms/technologies/wimax/304471.pdf>.

²³ *Id.* at 11. Wireless metropolitan area networks (“WMANs”) can span distances ranging up to 30 miles. WIRELESS BROADBAND TASK FORCE REPORT, *supra* note 20, at 17.

802.11 standard, can provide WLANs within small, defined areas, or “hot spots,” WiMAX can expand coverage to establish WMANs over entire cities.²⁴ The minimal installation needed for WiMAX also can significantly reduce costs. For example, whereas cellular Global System for Mobile Communications base stations require a power supply, air conditioning, and protection from the rain, one version of WiMAX consists of a box the size of a laptop computer which can be mounted on a pole or a building with none of the electrical or climate requirements.²⁵

A single WiMAX network can offer service in a range of up to fifty kilometers, or around thirty miles, with total data rates up to 75 Mbps.²⁶ A three to ten kilometer range, a more realistic range in densely populated areas due to decreasing amounts of bandwidth because of more users,²⁷ can deliver total data rates up to 40 Mbps.²⁸ This is “enough bandwidth to simultaneously offer hundreds of businesses with T-1-speed connectivity²⁹

²⁴ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 5.

²⁵ *Internet Links Boost Wealth*, BUSINESS DAY, Sept. 6, 2006, <http://www.businessday.co.za/Articles/TarkArticle.aspx?ID=2213498>. Noting that WiMAX is much less expensive to establish and maintain compared to Global System for Mobile Communications (“GSM”) cellular infrastructure, Stefano Mattiello, Motorola’s regional sales director for sub-Saharan Africa, stated that “We believe we can get connectivity charges down to R250 a month using this technology standard..” *Id.* He said Motorola is “testing WiMAX in other parts of Africa, and will do the same in [South Africa], once regulations permit it to do so.” *Id.*

²⁶ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 3. This allows “users to get broadband connectivity without the need of direct line-of-sight to the base station.” *Id.*

²⁷ Bandwidth, measured in bits or bytes per second, refers to the amount of data a network can carry in terms of “how much and how fast data flows on a given transmission path.” WIRELESS INTERNET INSTITUTE, THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES 120 (2003) [hereinafter THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES], available at <http://www.infodev.org/en/Publication.24.html> (follow “Download Now” hyperlink).

²⁸ WiMAX Forum-Technology, <http://www.wimaxforum.org/technology> (last visited Mar. 26, 2007). The WiMAX Forum is a leading non-profit corporation dedicated to promoting WiMAX deployments worldwide by ensuring the compatibility and interoperability of broadband wireless equipment. WiMAX Forum, WiMAX Forum Overview, <http://www.wimaxforum.org/about> (last visited Mar. 26, 2007) [hereinafter WiMAX Forum Overview]. The WiMAX Forum is the “exclusive organization dedicated to certifying the interoperability of [Broadband Wireless Access] products.” WiMAX Forum, WiMAX Certification Program, http://www.wimaxforum.org/certification/certification_program (last visited Mar. 26, 2007).

²⁹ T-1, or “Trunk Level” connections, offers “a digital transmission link with a signaling speed of 1.544 Mbps (1,544,000 bits per second) in both directions (i.e. send and receive).” HARRY NEWTON, NEWTON’S TELECOM DICTIONARY 878 (22nd ed. 2006). T-1 can be offered through leased service “as a channelized service (delivered as separate voice or data channels), or as an unchannelized raw bit stream . . . and do with the 1.256 Mbps bits as you wish.” *Id.* A person, if leasing an unchannelized approach, can split the T-1 connection for example “into 12 voice grade channels to support 12 voice conversations, and use the remaining 768 Kbps for either reasonably high-speed access to the Internet or for video con-

and thousands of residences with DSL-speed connectivity.”³⁰ Total WiMAX bandwidth is shared among all users,³¹ resulting in speeds which “equate to nearly 50 [T-1-speed] (1.544 Mbps) connections or 150 DSL connections (averages 500 kbps [kilobits per second]) per WiMAX transmitter.”³² In other words, a single WiMAX transmitter can offer the same connectivity previously possible only through dozens or hundreds of individual physical wire connections. The resulting potential for larger data transmission capability promises to enhance the quality and speed of “instant messaging, multiplayer interactive gaming, streaming media, [Voice over Internet Protocol (“VoIP”)],³³ video and teleconferencing, and media content downloads.”³⁴ Such capabilities have the potential to boost and enhance Wi-Fi networks and resolve the issues of cost and flexibility that have in part limited Wi-Fi networks from expanding further.³⁵ WiMAX can complement existing Wi-Fi deployments by providing economical ways to “expand deployment of Wi-Fi hot spots throughout campus environments, shopping centers and other outdoor venues where other backhaul alternatives are not readily available.”³⁶ Such enhancements, coupled with the avoidance of expensive physical connection installations, make WiMAX an attractive broadband option.

ferencing . . . or [use the unchannelized T-1] for AMT network[s], or for Internet access.”
Id.

³⁰ WiMAX Forum Overview, *supra* note 28.

³¹ Jennifer Farwell, *WiMAX Wireless Technology: Rising Star or Long-Term Loser?*, PCTODAY, Sept. 2005, at 80, available at <http://www.pctoday.com/editorial/article.asp?article=articles/2005/t0309/25t09/25t09.asp&guid>.

³² *Id.*

³³ “Voice over Internet Protocol (VoIP) allows an individual to make telephone calls using an Internet connection instead of a regular telephone line.” FED. COMM’NS COMM’N, CONSUMER FACT SHEET, VOICE OVER INTERNET PROTOCOL (VOIP) 1 (2006), available at <http://www.fcc.gov/cgb/consumerfacts/voip.pdf>.

³⁴ Mo Shakouri, *Assessing the Worldwide Potential for WiMAX*, 40 TELECOMM. AM., Jan. 2006, at 17, 18 (describing the different ways that WiMAX can be deployed in the future).

³⁵ See *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 3. Wi-Fi, which is set at the standard of IEEE 802.11, was originally “designed to address wireless local area coverage” needs and typically has been used to create WLANs. *Id.* at 5–6. However, “[a]s the number of users on an 802.11 standard increases . . . the efficiency of the network decreases because of the overhead of managing additional subscribers.” *Id.* at 7. Nevertheless, [t]he most common deployments . . . for wireless metro access to date are the 802.11b and 802.11g standards because of interoperability and the greater range they achieve in the 2.4-GHz band.” *Id.* at 6.

³⁶ Shakouri, *supra* note 34. Backhaul refers to when a “communications channel . . . takes traffic beyond its destination and back.” NEWTON, *supra* note 29, at 139. Backhauling might be done because it is cheaper than a direct route or “to accommodate changes in . . . calling or staffing patterns.” *Id.*

There are two WiMAX usage models: fixed and portable.³⁷ The fixed IEEE 802.16-2004 standard³⁸ is designed for fixed-access usage models.³⁹ The model consists of fixed stationary endpoints in which a mounted antenna is placed onto the subscriber's roof or mast like a satellite television dish.⁴⁰ The IEEE 802.16-2004 standard, available since 2004, offers subscribers a wireless alternative fixed broadband Internet access alternative to DSL, cable modem, or T-1 services.⁴¹ Flexibility and adaptivity across channels provide improved connectivity and better quality of service.⁴²

Fixed WiMAX is designed to improve last-mile delivery in multi-path interference, delay spread, and robustness⁴³ in addition to long-distance backhaul solutions.⁴⁴ Both "multi-path interference and delay spread improve performance where there is not a direct line-of-sight path between the base and subscriber station."⁴⁵ The fixed model also utilizes bandwidth more efficiently than Wi-Fi and reduces loss of bandwidth due to data retransmission.⁴⁶ The standard is intended for carrier-class operation⁴⁷ so that

³⁷ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 10 (listing the two types as portable WIMAX and 802.16-e WiMAX).

³⁸ The 802.16-2004 standard includes all prior fixed models, which are 802.16, 802.16a and 802.16c. Tim Sanders, *WiMAX/802.16 Revealed*, WI-FI PLANET, Sept. 25, 2005, <http://www.wi-fiplanet.com/tutorials/article.php/3550476>. The "IEEE 802.16a model addresses operations within the 2-11 GHz bands." WIRELESS BROADBAND TASK FORCE REPORT, *supra* note 20, at 21.

³⁹ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 10.

⁴⁰ *Id.*

⁴¹ *Id.* See also Paul Rubens, *WiMAX Edges Into the Mainstream*, Nov. 8, 2006, <http://www.enterprisenetworkingplanet.com/netsp/article.php/3642721> (discussing some of the disadvantages and also advantages WiMAX has over leased line or DSL options). Rubens states, "[o]ne of the advantages of WiMAX is that service providers like TowerStream can deliver [connections] at arbitrary bandwidths" which allows them to "turn up" the service to 5 Mbps, allowing customers like Newscast to "get more bandwidth for a short period of time." *Id.* This means getting "3 T1s when [customers] need it for less than half the price of a T1." *Id.*

⁴² *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* 22, at 11. WiMAX employs Orthogonal Frequency-Division Multiplexing ("OFDM"), which increases "spectral efficiency and robustness from interferences." WIRELESS BROADBAND TASK FORCE REPORT, *supra* note 20, at 21. Distortions increase when signals are reflected off of objects from the original desired source. *Id.* OFDM reduces the distortions by splitting signals into several narrower channels, thus allowing them to pass through buildings and trees. *Id.* Although Wi-Fi also uses OFDM, Wi-Fi only offers one-fourth of the OFDM options available as compared with fixed WiMAX. *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 10.

⁴³ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 10.

⁴⁴ *Id.* at 12.

⁴⁵ *Id.* at 10.

⁴⁶ *Id.* at 11.

⁴⁷ Carrier class refers to "telecom switching and transmission equipment that is targeted at local, long distance and international phone carriers, but not at end users [This] means that the equipment is (theoretically) more reliable because it's built better and

each user's throughput is not significantly decreased as more users share the aggregate bandwidth.⁴⁸ As a carrier-class solution, WiMAX can provide last-mile solution options by extending wireline Internet coverage to inaccessible, remote, or underserved markets while providing a high quality of service for end users.⁴⁹

The IEEE 802.16e standard is an amendment to the IEEE 802.16-2004 fixed model and is designed for portable usage for the mobile market.⁵⁰ Once deployed, WiMAX portable usage adapters will allow mobility for laptops and handheld devices.⁵¹ The 802.16e standard is expected to provide more flexibility and adaptability.⁵² Companies, such as Sprint Nextel, will launch trial markets for wireless broadband services utilizing the IEEE 802.16e standard at the end of 2007, although a more extensive network will not be deployed until at least 2008.⁵³

WiMAX operates in both licensed spectrum (2.5–2.69 GHz and 3.3–3.8 GHz) and license-exempt spectrum (5.15–5.85 GHz).⁵⁴ Licensed spectrum provides better quality of service and downlink power.⁵⁵ However, WiMAX networks that use the license-exempt spectrum are more practical solutions for rural and underdeveloped markets.⁵⁶ Faster rollout and lower initial costs are advantages that license-exempt solutions have over li-

stronger. And it's more expensive Most telecom gear is now carrier class." NEWTON, *supra* note 29, at 201.

⁴⁸ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 11.

⁴⁹ *Id.* at 10.

⁵⁰ *Id.*

⁵¹ See Kate Green, *WiMAX Cell Phones Edge Closer to Reality: Power-Saving Chips Are Paving the Way for Super-Broadband Handheld Devices*, TECH REV., June 26, 2006, http://www.technologyreview.com/read_article.aspx?id=17031&ch=infotech (explaining how WiMAX can increase the amount and quality of data and information cellular phones and other handheld, mobile devices can receive due to WiMAX's ability to access more bandwidth at a broader range).

⁵² The 802.16e applications are expected to use Scalable Orthogonal Frequency-Division Multiplexing Access ("SOFDMA"). FIXED, NOMADIC, PORTABLE AND MOBILE APPLICATIONS FOR 802.16-2004 AND 802.16e WiMAX NETWORKS, *supra* note 17, at 2. OFDMA used in fixed WiMAX, provides "more flexibility when managing different devices with a variety of antenna types and form factors." *Id.* at 8. SOFDMA enhances OFDMA because it scales the size to allow continual access by spacing the carrier across different channel bandwidths. *Id.* at 9.

⁵³ Press Release, Sprint Nextel, Sprint Nextel Announces 4G Wireless Broadband Initiative with Intel, Motorola and Samsung (Aug. 8, 2006), *available at* http://www2.sprint.com/mr/news_dtl.do?id=12960.

⁵⁴ *Understanding Wi-Fi and WiMAX as Metro-Access Solutions*, *supra* note 22, at 10.

⁵⁵ Intel, Inc., *Deploying License-Exempt WiMAX Solutions 4* (White Paper, 2005), *available at* <http://www.intel.com/netcomms/technologies/wimax/306013.pdf>. The licensed band has been used in much of the world, including North America, Latin America, Western and Eastern Europe and parts of Asia-Pacific, with spectrum ranging from 2.6 GHz to 4.2 GHz. *Id.*

⁵⁶ *Id.* at 5.

censed spectrum solutions.⁵⁷ Moreover, license-exempt equipment operates on globally harmonized spectrum that can be used worldwide since most countries use the 5 GHz spectrum.⁵⁸

B. Regulation and Deployment of WiMAX in the United States

The attention focused on WiMAX deployment has intensified, and the industry is moving to take advantage of the opportunities WiMAX promises. Dadi Perlmutter, senior vice president and general manager of Intel's mobility group, told a September 2006 Intel Developer Forum that "[t]he jewel of the crown for wireless connectivity is WiMAX."⁵⁹

Plans for American nationwide WiMAX networks are already underway.⁶⁰ Sprint Nextel is the largest of "any wireless carrier in any single

⁵⁷ *Id.* at 4–5.

⁵⁸ *Id.*

⁵⁹ Ames, *supra* note 14.

⁶⁰ Regulations in the United States have slowly made the deployment of broadband technologies like WiMAX more feasible. In 2004, the FCC created the Broadband Radio Service ("BRS") designation "to facilitate the ability of licensees and spectrum lessees to develop and deploy innovative technologies including low-power, mobile wireless broadband technologies in the band." WIRELESS BROADBAND TASK FORCE REPORT, *supra* note 20, at 52. See also *In re* Amendment of Parts 1, 21, 73, 74 and 101 of the Commission's Rules to Facilitate the Provision of Fixed and Mobile Broadband Access, Educational and Other Advanced Services in the 2150–2162 and 2500–2690 MHz Bands; Part 1 of the Commission's Rules - Further Competitive Bidding Procedures; Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and the Instructional Television Fixed Service Amendment of Parts 21 and 74 to Engage in Fixed Two-Way Transmissions; Amendment of Parts 21 and 74 of the Commission's Rules With Regard to Licensing in the Multipoint Distribution Service and in the Instructional Television Fixed Service for the Gulf of Mexico; Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, *Report and Order and Notice of Further Rulemaking*, 19 FCCR 14165 (Jul. 29, 2004). In 2006, the FCC held an Advanced Wireless Solutions ("AWS") auction which resulted in \$12.2 billion in bids. Press Release, Fed. Comm'n Comm'n, FCC Grants First Advanced Wireless Services Licenses Won in Auction No. 66 (Nov. 29, 2006), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-268728A1.pdf. The auction was for spectrum in the 1.7 GHz to 2.1 GHz range. *Id.* FCC Commissioner, Jonathan S. Adelstein, believed the auction was "critical for competition," as it would offer opportunities for consumers to "get a broadband 'third pipe' beyond today's prevalent broadband offerings" from wireline telephone and cable companies. Mark Rockwell, *AWS Consequential*, WIRELESSWEEK, May 15, 2006, <http://www.wirelessweek.com/article/CA6334944.html?spacedesc=Features>. The 1.7 GHz to 2.1 GHz spectrum is ideal for wireless broadband because of its versatility and ability to support an array of wireless technologies, including Third Generation ("3G") technologies and emerging Fourth Generation ("4G") wireless technologies like WiMAX. Marguerite Reardon, *Why Cable Companies, Google are Eying Wireless Spectrum*, CNET, May 11, 2006, http://news.com.com/2100-1039_3-6071163.html. T-Mobile won the most spectrum, followed by Verizon subsidiary Cellco Partnership and Spectrum Co., a consortium of cable companies Time Warner Cable, Cox Communications, Comcast, and Bright House Networks. Frank Ahrens, *FCC Wireless Auction Could Open Up Airwaves*, WASH. POST, Sept. 19, 2006, at D01.

spectrum band” to hold 2.5 GHz spectrum licenses, which cover 85 percent of households in the top 100 markets in the United States.⁶¹ In August 2006, Sprint Nextel announced its plans to deploy the first 4G nationwide broadband mobile infrastructure network, in cooperation with Intel, Motorola, and Samsung, using the mobile WiMAX IEEE 803.16e-2005 technology standard.⁶² The service is expected to be available to as many as 100 million people in 2008.⁶³ Investments in the Sprint Nextel 4G mobile broadband network are expected to be \$1 billion in 2007 and between \$1.5 billion and \$2 billion in 2008.⁶⁴ Plans also include deployment of mobile WiMAX-enabled computer chips to support advanced wireless broadband services.⁶⁵ Intel also has plans to deliver an integrated Wi-Fi and WiMAX chip by 2009.⁶⁶ WiMAX-related investments in Clearwire, the next largest 2.5GHz spectrum holder allocated for WiMAX after Sprint Nextel have also been substantial.⁶⁷ Intel invested \$600 million into Clearwire as part of

The FCC also plans a 2008 auction for the remaining 700 MHz spectrum band. *In re* Former Nextel Communications, Inc. Upper 700 MHz Guard Band Licenses and Revisions to Part 27 of the Commission's Rules Development of Operational, Technical and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through the Year 2010, *Order*, ¶ 17, 21 F.C.C.R. 10,413 (Sept. 8, 2006). Broadband currently is not allocated in this spectrum, but the FCC's stated objective is to "maximize opportunities for broadband use of 700 MHz spectrum due to the many benefits of broadband communications." *In re* Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band; Development of Operational, Technical and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through the Year 2010, *Ninth Notice of Proposed Rulemaking*, 21 F.C.C.R. 14,837, ¶ 12 (Dec. 20, 2006). The FCC believes that reallocation of the 700 MHz band "may best promote the rapid deployment of a nationwide, interoperable, broadband public safety network, and thereby improve emergency responsiveness." *Id.* ¶ 3.

⁶¹ Sprint Nextel, *supra* note 53.

⁶² *Id.*

⁶³ *Id.*

⁶⁴ *Id.* Perhaps a foreshadow of this recently announced plan, Sprint Nextel embarked upon a joint venture in 2005 with Comcast, Time Warner Cable, Cox Communications, and Advance/Newhouse Communications, aiming to explore potential wireless technologies for potential bundled wireline and wireless services. Press Release, Sprint Nextel, Sprint Nextel, Comcast, Time Warner Cable, Cox Communications and Advance/Newhouse Communications to Form Landmark Cable and Wireless Joint Venture (Nov. 2, 2005), http://www2.sprint.com/mr/news_dtl.do?id=8961. Sprint Nextel is the only wireless company that does not offer bundled consumer packages with cable companies; such deals illustrate endeavors to expand services. See Lindsay Schroth, *The Future of WiMAX*, TELEPHONY ONLINE, June 6, 2005, http://telephonyonline.com/mag/telecom_future_wimax/.

⁶⁵ *Id.*

⁶⁶ *Intel Merging Wi-Fi with WiMAX*, RED HERRING, Mar. 8, 2006, <http://www.redherring.com/Article.aspx?a=16015&hed=->.

⁶⁷ Ephraim Schwartz, *Behind the Push for WiMAX*, INFOWORLD, Oct. 24, 2006, http://www.infoworld.com/article/06/10/24/44OPreality_1.html.

a \$900 million financing scheme, with Motorola also investing in Clearwire.⁶⁸

Although widespread WiMAX access has yet to materialize, WiMAX has been deployed in a very limited fashion in the United States by small service providers like TowerStream.⁶⁹ Service is reported to be more reliable than T-1 services, often at half the cost.⁷⁰ An additional advantage offered by some WiMAX providers is bandwidth flexibility. Because WiMAX can connect at arbitrary bandwidths, service providers can “turn up” the service to 5 Mbps, allowing customers to have more bandwidth for a short period of time, for example, to upload large amounts of data for off-site backup.⁷¹ Such bandwidth is comparable to the bandwidth provided by three T-1 connections, yet offered for less than half the price of a single T-1 connection.⁷² Given the promise of these small deployments, WiMAX’s future impact on prices and connectivity could be profound.

Operator costs for the WiMAX spectrum are expected to be significantly lower as compared with other technologies, like 3G.⁷³ One study found that a WiMAX network “has a significant cost advantage over 3G starting at

⁶⁸ Press Release, Intel, Clearwire Secures \$900m In Financing Round Led by Intel Capital and Announces the Sale of NextNet Wireless to Motorola (July 5, 2006), *available at* <http://www.intel.com/pressroom/archive/releases/20060705corp.htm?cid=rss-83642-c1-133110>.

⁶⁹ See Towerstream, Towerstream Broadband Wireless ISP for T1 Access Service in New York, Chicago, Los Angeles, WiMAX Forum Member, <http://www.towerstream.com/content.asp?home> (last visited Mar. 27, 2007).

⁷⁰ Rubens, *supra* note 41. WiMAX is currently available in some parts of cities such as New York, Chicago, Boston, Los Angeles, and San Francisco. *Id.* Jim Sulley, a principal at New York based media library Newscast, stated that they had a T-1 capacity WiMAX connection from a base station on the Empire State Building operated by Towerstream and paid around half of what they paid for a conventional T-1 connection and that the WiMAX connection was more reliable. *Id.*

⁷¹ *Id.*

⁷² *Id.*

⁷³ ADLANE FELLAH, MARAVEDIS, SPECTRUM ANALYSIS – THE CRITICAL FACTOR IN BWA/WiMAX VERSUS 3G 6 (2006), *available at* http://www.frontpagepr.com/clients/maravedis/research_report_toc/3G_vs_wimax_spectrum_toc_1-2006.pdf. 3G generally refers to the “next generation of wireless mobile communications networks.” NEWTON, *supra* note 29, at 52. 3G networks enhance GSM cellular networks by providing “greater bandwidth, more sophisticated compression techniques, and the inclusion of in-building systems.” *Id.* at 62. GSM “is the standard digital cellular (also called mobile) phone service . . . in 85 countries” and is used by certain service providers in the United States like VoiceStream or Cingular. *Id.* at 434. 3G networks upgrade existing GSM networks “on a non-disruptive basis.” *Id.* at 62. This results in faster data rates than second generation systems like GSM networks at a minimum of 144 [kbps] for all radio environments or 2 [Mbps] megabits per second in low-mobility and indoor environments. Dr. Patrick Xavier, *Licensing of Third Generation (3G) Mobile: Briefing Paper 6* (Int’l Telecomm. Union, Briefing Paper, 2001), http://www.itu.int/osg/spu/ni/3G/workshop/Briefing_paper.PDF. The first generation was analog cellular, and the second generation refers to today’s digital cellular system. *Id.*

about 200 busy hour users.”⁷⁴ This means that “WiMAX network operators [have] a fundamental cost advantage that will enable them to offer services with higher performance and at a lower price than 3G.”⁷⁵ These operators will also be able to provide competitive VoIP services.⁷⁶ In Europe, where WiMAX has been more widely deployed, the average 3G spectrum cost per hertz is much higher: 1,000 times more than the average Broadband Wireless Access (“BWA”) per WiMAX spectrum cost per hertz.⁷⁷ A higher aggregate spectrum in the BWA/WiMAX spectrum minimizes the amount of equipment needed due to the lower hertz, and thus lowers the costs.⁷⁸ Lower costs have resulted in a higher number of licensees, which translates into more providers.⁷⁹ The future of WiMAX has been regarded with both speculation and enthusiasm, but until full-scale WiMAX networks are widely deployed, it remains to be seen whether the reality can live up to the hype.⁸⁰

⁷⁴ Ian Cox & Bob Larribeau, *Broadband Strategies for the Mobile Market 7* (Telecom-view, White Paper, 2006).

⁷⁵ *Id.*

⁷⁶ *Id.*

⁷⁷ FELLAH, *supra* note 73, at 6.

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ One possible contender against WiMAX is Mobile Broadband Wireless Access (“MBWA”), otherwise known as “Mobile-Fi,” which comes from the IEEE 802.20 mobile broadband standard. Scott Woolley, *Zapping the Competition: How Companies Are Using Obscure Standards-Setting Bodies to Cripple New Technologies and Hog-tie Rivals*, FORBES, Oct. 2, 2006, at 44–46. Remarks have been made of a Mobile-Fi/WiMAX struggle, deemed to potentially intensify in the near future. *Id.* The technology, however, is involved in a struggle of its own over technical standards relating to antifraud issues, most recently between Qualcomm and the IEEE and between the chipmaker Rambus and the Federal Trade Commission. *Id.* Another dispute that has been developing has been between Qualcomm and Broadcom. *Id.* Qualcomm recently made an \$800 million purchase of Flarion, a holder of key patents that will likely define the standard. *Id.* In *Broadcom Corp. v. Qualcomm, Inc.*, Broadcom asserted that “Qualcomm is engaging in the same type of anticompetitive conduct that it used to monopolize the [Code Division Multiple Access] CDMA technology and chipset market to monopolize the [Universal Mobile Telephone System] UMTS market.” *Broadcom Corp. v. Qualcomm, Inc.*, No. 05-3350, 2006 WL 2528545, at *2 (D.N.J. Aug. 31, 2006). Most of Broadcom’s allegations were based on federal antitrust claims under the Sherman Antitrust Act and the Clayton Act. *Id.* Both Broadcom and Qualcomm had developed UMTS chipsets that would compete with each other. *Id.* One central dispute was on the fact that Qualcomm controls the patent rights that must be obtained in order to manufacture and distribute UMTS chipsets. *Id.* Broadcom sought a license from Qualcomm for the use of the patents and alleged that “Qualcomm has refused to license the patents on [fair, reasonable, and non-discriminatory] FRAND terms, in violation of its commitment to the [standards development organization] SDO.” *Id.* The district court granted Qualcomm’s motion to dismiss. *Id.* Broadcom plans on refileing its suit. Woolley, *supra* note 80.

C. Global Deployment

Global WiMAX expenditures are predicted to rise from \$655 million in 2006 to \$7.36 billion by 2009.⁸¹ By 2009, the number of broadband mobile wireless subscribers in North America will be less than the number of subscribers in Europe and Asia, and North America is predicted to “use WiMAX aggressively to catch up.”⁸² Companies’ expenditures on wireless broadband technologies like WiMAX are projected to rise from a 22.5 percent share of total expenditure to a 63 percent share.⁸³ By 2009, cellular operators are expected to account for 17 percent of total WiMAX equipment purchases, which would make them “the second largest spenders on WiMAX equipment.”⁸⁴ Analysts anticipate that wired, not wireless, operators providing telephone and Internet data services will be the largest WiMAX investors as they seek ways to extend and enhance their services.⁸⁵ WiMAX networks are already in testing or deployment phases in nations such as France, Spain, Ireland, Poland, Finland, Ukraine, Austria, Slovakia, Mexico, the Dominican Republic, Uruguay, and Guatemala.⁸⁶

Because the portable version of WiMAX will not be deployable for at least several more years, WiMAX corporations have dedicated efforts to promote the fixed WiMAX version, and are primarily focused on markets with the largest growth potential: the developing world. Developing nations are expected to account for more than 60 percent of total worldwide business for fixed WiMAX networks by 2011.⁸⁷ Intel, which is strongly promoting WiMAX across the developing world⁸⁸ is currently working with Internet service providers (“ISPs”) in India to offer broadband con-

⁸¹ TRENDSMEDIA, OPERATOR SPENDING ON WiMAX: WiMAX DEPLOYMENTS AND INVESTMENT 2006–9: SUMMARY 4 (July 2006), *available at* <http://www.trendsmidia.com/pdf/WimaxOperatorSpending.pdf>.

⁸² Cox & Larribeau, *supra* note 74, at 8–9.

⁸³ TRENDSMEDIA, *supra* note 81, at 4.

⁸⁴ *Id.* at 5.

⁸⁵ *Id.* at 8.

⁸⁶ Michael Singer, *Intel Pushes WiMAX Around the Globe*, CNET NEWS.COM, Nov. 10, 2005, http://news.com.com/Intel+pushes+WiMax+around+the+globe/2100-7351_3-5944874.html.

⁸⁷ *TelecomView Study Says Fixed WiMAX Gaining a Strong Foothold*, BUSINESSWIRE, June 19, 2006, http://www.findarticles.com/p/articles/mi_m0EIN/is_2006_June_19/ai_n16485402 (referring to a recent study released by TelecomView).

⁸⁸ Intel’s interest in the developing world preceded WiMAX. Intel is investing one billion dollars into its “World Ahead Program,” which plans to “introduce the digital world to the next billion new users.” See Intel, *Intel World Ahead Program – Overview*, <http://www.intel.com/intel/worldahead/> (last visited Mar. 26, 2007). The World Ahead Program has provided solutions to users from Peru to Russia to Vietnam, overcoming problems such as lack of power, an individual’s inability to afford computers, or incompatible data or software systems. *Id.* (then follow country hyperlink on world map).

nectivity using WiMAX in Internet cafes at railway stations,⁸⁹ as well as plans to begin WiMAX network trials in the Indian cities of Mumbai, Delhi, Bangalore and Pune.⁹⁰ The number of WiMAX subscribers in India is projected to reach 13 million by 2012.⁹¹ Intel has also formed a WiMAX joint venture with Orascom, a telecommunications provider in Egypt,⁹² and announced plans to bring more WiMAX to Southeast Asia.⁹³

Other corporations have made commitments to bring WiMAX to the developing world. Samsung signed an agreement in 2006 with TVA Sistema de Televisao S.A., a Brazilian communication service provider, to commercialize a Mobile WiMAX platform and WiMAX services over the next few years.⁹⁴ Samsung has begun to deploy Mobile WiMAX platforms in Brazil, which is Latin America's largest market.⁹⁵ Samsung is also negotiating with operators in Southeast Asia and Eastern Europe to launch WiMAX services.⁹⁶ In 2006, a Chilean firm, Entel, announced plans to implement WiMAX networks in fourteen cities to provide services to small and medium-sized companies.⁹⁷ Algeria also began offering WiMAX

⁸⁹ John Ribeiro, *Intel Outlines Plan to Bridge India's Digital Divide*, INFOWORLD DAILY NEWS ONLINE, May 23, 2006, http://www.infoworld.com/article/06/05/23/78588_HNintelbridgeindia_1.html.

⁹⁰ Posting of Shailaja Neelakantan to <http://gigaom.com/2006/08/05/intel-plans-india-wimax-trials/> (Aug. 5, 2006, 8:03 PT).

⁹¹ *Id.*

⁹² *IntelCapital Invests in WiMAX*, RED HERRING, May 22, 2006, <http://www.redherring.com/Article.aspx?a=16951&hed=>.

⁹³ Press Release, Intel, Intel Spurs WiMAX Deployment in Southeast Asia: Malaysia, Thailand, the Philippines, Indonesia, Vietnam to Benefit from Asian Broadband Campaign (Sept. 22, 2006), *available at* <http://www.intel.com/pressroom/archive/releases/20050922comp.htm>.

⁹⁴ Press Release, Samsung, Samsung Electronics and TVA Signs a Contract to Bring Mobile WiMAX to Brazil, (Nov. 8, 2006), *available at* http://www.samsung.com/PressCenter/PressRelease/PressRelease.asp?seq=20061108_000299201.

⁹⁵ *Id.*

⁹⁶ Bruce Einhorn, *Telecoms Hungry for Next Billion Callers: Emerging Markets Look Like the Best Bet for the Next Wave of Wireless Customers, According to Talk at ITU Telecom World in Hong Kong*, BUSINESS WEEK ONLINE, Dec. 7, 2006, http://www.businessweek.com/globalbiz/content/dec2006/gb20061207_197764.htm?chan=search.

⁹⁷ Robert Hoskins, *Entel Deploying First WiMAX National Network in Chile Using Alvarion's BreezeMax Solution*, BROADBAND WIRELESS EXCHANGE MAGAZINE, June 8, 2006, <http://www.bbwxchange.com/pubs/2006/06/08/page1409-151775.asp>. Competition in the Chilean WiMAX market is likely to increase, and VTR, the leading cable operator, and the Chilean subsidiary of Mexican telecom giant Telmex [as well as Telefonica CTC Chile and Manquehue Net] are . . . likely to provide strong competition." *WiMAX Competitors Line Up and Race Ahead in Chile*, WiMAX DAY, Nov. 14, 2006, <http://www.wimaxday.net/site/2006/11/14/wimax-competitors-line-up-and-race-ahead-in-chile/>.

commercially in 2005, making it the first country in North Africa and the Middle East to deploy WiMAX.⁹⁸

“Timing, pricing, and scale will be critical to WiMAX success, and vendors must prove that WiMAX can deliver much more than basic broadband.”⁹⁹ But if timing is everything, WiMAX may have arrived at precisely the right moment.

III. NOT A ONE-SIDED SOLUTION: AMBITIONS FOR ECONOMIC DEVELOPMENT IN SUB-SAHARAN AFRICA

While the push to integrate WiMAX in developing nations is easily viewed as a one-sided effort by telecommunications companies to expand markets and profits, the larger picture reveals a more intricate and complex reality. WiMAX’s growth in developing nations could not have gained momentum without the interest and motivation of countries, businesses, and individuals in the developing world to use WiMAX. When asked why he chose WiMAX as the distribution for infrastructure, Leon Ntale, President of Microcom, the leading wireless ISP in the Democratic Republic of Congo, gave a response that is echoed throughout the developing world: “[w]ireless broadband is the most cost effective means to provide high-speed data to our customers in the city of Kinshasa, a city of approximately 8 million inhabitants with little wired infrastructure.”¹⁰⁰

A. With Scarcity Comes Possibility

Developing nations have “a unique opportunity to ‘leapfrog wired infrastructure.’”¹⁰¹ The lack of infrastructure and competition for wired technology in developing nations may prompt the deployment of all-inclusive, comprehensive wireless networks to occur much faster than in developed nations.¹⁰² Furthermore, advanced ICTs have the potential to support “technological leapfrogging” for developing nations because much of the

⁹⁸ *Algeria Becomes the World WiMAX Pioneer*, MENAFN PRESS, Apr. 23, 2006, http://www.menafn.com/qn_news_story_s.asp?storyid=1093110333. Algeria’s “tough and mountainous terrain makes it an ideal candidate for wireless connectivity solutions,” and the “goal is to build a wireless broadband backbone covering the national territory, to develop the metropolitan broadband networks, and to set up an independent new generation telecom industry.” *Id.*

⁹⁹ Schroth, *supra* note 64.

¹⁰⁰ Robert Hoskins, *ISP in Republic of Congo First to Deploy Alvarion’s WiMAX-Ready Network in Central Africa*, BROADBAND WIRELESS EXCHANGE MAGAZINE, Apr. 25, 2005, <http://www.bbwxexchange.com/publications/newswires/page546-2082066.asp>.

¹⁰¹ Ranty Islam, *Solar Power May Soon Bring the Web to Remote Areas*, CHRISTIAN SCI. MONITOR, Aug. 31, 2006.

¹⁰² *Id.*

work in developing the technology has already been done.¹⁰³ “[T]he components of global networks and software applications are available on the international market and they are easily transportable.”¹⁰⁴

Numerous obstacles have traditionally hindered comprehensive telecommunications infrastructure deployment in developing nations. Construction is halted due to an inability to finance projects.¹⁰⁵ Rugged terrain and/or the remoteness of rural towns and villages complicate logistics and increase expenditures.¹⁰⁶ Labor and transportation costs increase as more time is needed to ship and transfer equipment, to install telephone lines, or to build communications towers in mountainous or rocky areas.¹⁰⁷ As a

¹⁰³ Robin Mansell, *Digital Opportunities and the Missing Link for Developing Countries*, 17 OXFORD REV. OF ECON. POL’Y 282, 284 (2001).

¹⁰⁴ *Id.*

¹⁰⁵ International organizations “such as the World Bank, Inter-American Development Bank and Asian Development Bank have provided billions in loans and credits for telecom projects in developing countries.” Edward R. Leahy & Michael O’Brien, *Telecommunications Law and Technology in the Developing World*, 22 B.C. INT’L & COMP. L. REV. 1, 5 (1999). However, telecommunications corporations have increasingly comprised “the most important group of potential telecom investors for developing nations.” *Id.* at 8. As the World Development Report states, “[n]on-transparent or unpredictable government policies can adversely affect investors’ decisions and thereby chill incentives to invest in a particular country.” LUISA E. BERNAL ET AL., WORLD TRADE ORGANIZATION, THE WORLD DEVELOPMENT REPORT 2005: AN UNBALANCED MESSAGE OF INVESTMENT LIBERALIZATION ¶ 10 (2004), available at <http://www.globalpolicy.org/soecon/ffd/fdi/2004/wdrcritique.pdf>. Additional telecommunications regulations often of concern to investors and local businesses include issues of private investment, competition, providing affordable and reliable information and telecommunications technology. MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 218. Additional concerns include issues of privatizing national monopolies and state-owned enterprises and also providing broader access to telecommunications tools and software. *Id.* Such concerns in African governments and policies have deterred many investors. See *infra* Part V for a discussion of issues that have encumbered the telecommunications sectors of many nations in sub-Saharan Africa and how efforts are being made to overcome them.

¹⁰⁶ For example, bridging the great disparity between urban and rural rates of ICT and telecommunications penetration and dealing with broad and diverse terrain have been major challenges for the telecommunications sector in India. As of January 2006, the urban teledensity in India was 30 percent, but only 2 percent in the rural areas. Rekha Jain, *Accelerating Indian Rural Telecom Services: Policy and Regulatory Approaches* (2005), <http://web.si.umich.edu/tprc/papers/2006/594/Accelerating%20Indian%20Rural%20Telecom%20Services%20Policy%20and%20Regulatory%20Approaches.pdf>. Generally speaking, teledensity is a “measure of phone lines per 100 of population.” NEWTON, *supra* note 29, at 896. A teledensity between 40 and 50 is average. *Id.* Having over 70 phone lines per 100 users is considered to be at an advanced level, whereas less than 10 is considered to be deficient. *Id.*

¹⁰⁷ The lack of telecommunications infrastructures creates logistical problems for other industries. In China, for example, the increase in foreign investment and manufacturing has increased the demand for higher quality logistics services and “has strained its logistics infrastructure to the limit.” Felix W.H. Chan, *Logistics Management and Its Legal Environment in China*, 31 H.K.L.J. 497, 500 (2001). The lack of tracing services has created a serious problem for Chinese manufacturers attempting to ensure delivery of cargo. *Id.* at

result, the demand for telecommunications equipment and services considerably exceeds the existing supply.¹⁰⁸ In some nations, civil wars or conflicts have destroyed existing communications lines and towers beyond repair.¹⁰⁹ Ongoing conflicts continue to delay reconstruction. Foreign investors forego projects as markets remain unstable, and regulations, or their enforcement, remain absent.¹¹⁰ Many governments also resist privatization or the enforcement of transparency and accountability in domestic financial or government institutions.¹¹¹

The absence of adequate telecommunications infrastructures has resulted in minimal access to ICTs for a large percentage of individuals around the world, a fact reflected in the respective levels of regional Internet penetration.¹¹² The Middle East holds roughly 2.9 percent of the world's population, yet Internet users in the Middle East comprise only 1.8 percent of

503. The problem is attributable to the lack of telecommunications and information technologies needed to adequately track and also prevent theft of cargo. *Id.*

¹⁰⁸ Leahy & O'Brien, *supra* note 105, at 11. "[T]he number of unmet applications for basic telephone connections often exceeds the number of existing lines." *Id.*

¹⁰⁹ The conflict in Liberia during the early 1990s devastated the country's domestic infrastructure. Efforts to rebuild the country's infrastructure, such as roads and telecommunications lines, substantially overwhelmed the government and the country for years after the conflict subsided. Many countries in South Eastern Europe have also had difficulties building transportation or telecommunications infrastructures after years of conflict. *See* U.N. COMM'N ON HUMAN DEV. & SOC'Y, Second Meeting the Committee on Human Development and Civil Society/UNAIDS Regional Conference, Addis Ababa, Eth., Ma 2-27, 2003, *Countries Emerging From Conflict: Lessons On Partnership In Post-Conflict Reconstruction, Rehabilitation And Reintegration*, ¶¶ 43-51, U.N. Doc. ECA/DMD/CHDCS/02/2, available at

http://www.uneca.org/chdcs/second_meeting_countries_emerging_from_conflict.htm.

¹¹⁰ The absence of a legal and judiciary body minimizes predictability as well as minimizes the chances that risks will be allocated, conflict or dispute resolutions will occur, or that gains and losses will be equitably or fairly distributed. Gary Goodpaster, *Law Reform in Developing Countries*, 13 *TRANSNAT'L L. & CONTEMP. PROBS.* 659, 672 (2003). The rule of law, or its absence, affects investors' expectations and thus decisions; "an ideal rule of law system theoretically provides security and predictability," thus affecting "the expected values of economic decisions." *Id.* at 674.

¹¹¹ *Id.* at 680. When efforts are made to move to a rule of law system, existing interests are threatened and those holding these interests will resist them. *Id.* More ambitious reforms to provide or enforce basic rights can lead to stronger and riskier reactions by those in power or authority. *Id.*

¹¹² *See Information Economy Report 2006, supra* note 13, at 5 (explaining that between 2004–2005 "the digital divide between developed and developing countries is maintained in terms of Internet penetration" and that developed economies "still account for more than half of Internet users worldwide"); *id.* at 11 (discussing how the lack of economies of scale and infrastructure" have reduced the incentive to bring broadband to users outside of rural areas); *see also* Internet World Stats, World Internet Usage Statistics News and Population Stats, <http://www.internetworldstats.com/stats.htm> (last visited Mar. 27, 2007); Int'l Telecomm. Union, What's the State of ICT Status Around the World?, <http://www.itu.int/newsroom/wtdc/2006/stats/index.html> (last visited Jan. 20, 2007) [hereinafter What's the State of ICT Status Around the World?] (illustrating, for example, how a more developed city like London has more Internet users than the entire nation of Pakistan).

worldwide Internet users.¹¹³ Although Asia's Internet users comprise 35.5 percent of worldwide usage, the Internet has reached only 10.6 percent of the Asian population.¹¹⁴ Africa is home to 14.2 percent of the world's population, yet only 3 percent of global Internet users are found in the region.¹¹⁵ "In 2004, less than three out of every 100 Africans use[d] the Internet, compared with an average of 1 out of every 2 inhabitants of the G8 countries."¹¹⁶ As of 2006, the number of Internet users in the United States alone was more than eight times the number in the entire continent of Africa.¹¹⁷

Wireless technologies and networks allow nations to circumvent traditional landlines and avoid the expenses to establish them, the costs of which are well beyond what most developing nations can afford.¹¹⁸ Wireless communications systems involve only transmitters and receivers; "[t]here is nothing in the middle."¹¹⁹ Wireless networks are more flexible than wired networks, and are less likely to suffer declines in performance as the number of users on the network increases.¹²⁰ Thus, fewer limitations hinder users connecting onto wireless networks.¹²¹ Both Internet services and wireless broadband Internet access can be provided with much less investment in infrastructure.¹²² WiMAX, compared with any other wired or wireless solution, has the potential to offer the greatest opportunity to help bridge the digital divide due to ease of installment, wider coverage, and higher flexibility and adaptability.¹²³

¹¹³ Internet World Stats, *supra* note 112.

¹¹⁴ *Id.*

¹¹⁵ *Id.*

¹¹⁶ What's the State of ICT Status Around the World?, *supra* note 112. The Group of 8, or G8, includes the G-7 countries and Russia. The G-7 countries are Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. State Dept., Group of 8 (G8): What Is the Group of 8?, http://usinfo.state.gov/ei/economic_issues/group_of_8.html (last visited Mar. 27, 2007). The G-7 countries "account for about two-thirds of the world's economic output." *Id.*

¹¹⁷ What's the State of ICT Status Around the World?, *supra* note 112.

¹¹⁸ James Trulove, *WiMAX's Promise for Developing Countries*, WiMX.COM, Apr. 14, 2005, http://www.wimax.com/commentary/spotlight/wimaxspotlight2005_04_14.

¹¹⁹ KEVIN WERBACH, RADIO REVOLUTION: THE COMING AGE OF UNLICENSED WIRELESS 5 (2004), *available at* <http://wireless.fcc.gov/outreach/2004broadbandforum/comments/NewAmericaPublicKnowledge.pdf>.

¹²⁰ Daria Taglioni, *Wired-less Development*, OECD Observer, No. 240/241 (Dec. 2003), *available at* http://www.oecdobserver.org/news/fullstory.php/aid/1158/Wired-less_development.html.

¹²¹ *Id.*

¹²² Trulove, *supra* note 118.

¹²³ CAYLA ET AL., *supra* note 12, at 6.

B. Transforming Potential into Reality

Beyond the push to obtain wireless technologies like WiMAX is the underlying drive for economic development. Utilizing ICTs to foster economic development is a concept that has been acknowledged by developing nations and international organizations.¹²⁴ A strong correlation exists between the level of ICT development and the level of income.¹²⁵ ICTs provide means to improve economic and financial opportunities, and improved “telecommunications can contribute substantially to lower prices and better delivery [of products], increasing competitiveness.”¹²⁶

¹²⁴ The United Nations (“UN”) has recognized and supported the catalyzing role that ICTs have in promoting and facilitating the achievement of development goals. G.A. Res. 60/205, 1, U.N. Doc. A/RES/60/205 (Mar. 16, 2006). One of the goals of the Resolution was to reaffirm its commitment to “[p]romote and facilitate, as appropriate, access to, and development, transfer and diffusion of, technologies . . .” *Id.* at ¶ 1. In addition, the UN has begun work on an initiative – the Global Alliance – to develop “a decentralized ‘network of networks’ on a global scale . . .” Press Release, Secretary General, United Nations Secretary-General Welcomes “Network of Networks” to Spread Digital Revolution, U.N. DOC DEV/2593 (Sept. 27, 2006), available at <http://www.un.org/News/Press/docs/2006/dev2593.doc.htm>. UN Secretary General Kofi Annan told leaders from business, finance, and governments that efforts in the Global Alliance to increase access to digital technology give an important direction to “the use of ICT as a tool for advancing development.” The Secretary General, *Statement by U.N. Secretary General Kofi Annan*, U.N. DOC. DEV/2592 (Sept. 27, 2006), available at <http://www.un.org/News/Press/docs/2006/sgsm10662.doc.htm>. The World Bank has also emphasized the role ICTs can have in development policies. WORLD BANK, INFORMATION AND COMMUNICATIONS FOR DEVELOPMENT: GLOBAL TRENDS AND POLICIES 2006 4 (2006) available at http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2006/04/20/000012009_20060420105118/Rendered/PDF/359240PAPER0In101OFFICIAL0USE0ONLY1.pdf.

¹²⁵ *The Digital Divide Report*, *supra* note 2, at 1. Providing information technology to more individuals is viewed not only as a key for development but also an indicator of growth. See generally U.N. Conference On Trade & Dev., *Information Economy Report 2005*, U.N. Doc. UNCTAD/SDTE/ECB/2005/1 (2005) available at http://www.unctad.org/en/docs/sdteedc20051_en.pdf [hereinafter *Information Economy Report 2005*]. Recent studies have correlated ICT usage with economic development. Results of one study, for example, suggested that the use of information technology is higher in more developed countries and that widespread deployment of ICTs is more likely to occur among the countries that “have more GNP per capita, a few per cent of unemployment, and use more expenditure on education.” Ashraf Ragab El-Ghannam, *The Influence of Demographic and Socio-Economic Factors Upon Information Technology Among More, Moderate, and Less Developed Countries in the Globe*, 25 INT’L J. SOC. & SOC. POL’Y 37, 46 (2005). Throughout this section and throughout this article, it remains important to note that the benefits of the Internet and ICTs are assumptions not to be taken as facts and which do not automatically materialize into reality. Some scholars argue that the Internet in fact “tends to reinforce existing class and social relations both within and across countries.” Guillen & Suarez, *supra* note 2, at 682. See generally ROBERT W. MCCHESENEY, RICH MEDIA, POOR DEMOCRACY (1999); VINCENT MOSCO, THE POLITICAL ECONOMY OF COMMUNICATION (1996).

¹²⁶ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 219.

At first glance, giving priority to the telecommunications sector in sub-Saharan Africa may seem unwarranted in light of more pressing concerns that have burdened African individuals and governments for decades. Although African economies recorded an average GDP growth rate of 5.4 percent in 2005, the highest in decades,¹²⁷ growth throughout the continent continues to be uneven and challenges still remain.¹²⁸ Persistent drought continues to threaten agricultural production.¹²⁹ The spread of HIV/AIDS has implications not only on the local levels but on the national and regional level in terms of employment and labor productivity.¹³⁰ Insufficient diversification of exports and products, an absence of efficient public infrastructures, and unreliable energy supplies leave many countries vulnerable to financial collapses and hinder international economic competitiveness and economic growth.¹³¹

Poverty, including the working poor¹³² and total poverty, and unemployment are significant factors constraining growth. Notwithstanding the recent rise in GDP,¹³³ poverty levels in sub-Saharan Africa are getting worse.¹³⁴ Furthermore, between 1993 and 2003 sub-Saharan Africa was the only region in the world in which labor productivity levels decreased¹³⁵

¹²⁷ CAPITAL FLOWS AND DEVELOPMENT FINANCING IN AFRICA, *supra* note 6, at 3.

¹²⁸ *Id.* at 4.

¹²⁹ *Id.* at 58.

¹³⁰ *Id.*

¹³¹ *Id.* at 58–59.

¹³² The “working poor” refers to individuals who have jobs but whose incomes are below the poverty line. MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 62.

¹³³ See *supra* note 125 and accompanying text.

¹³⁴ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 1. The region’s unemployment rate was 10.9 percent in 2003. *Id.* at 61. However, “[p]ure unemployment numbers mask information on the composition of the jobless population and therefore miss out on important particularities of the unemployed, such as socio-economic background, ethnic origin, and duration of unemployment.” *Id.* at 26. Thus, going beyond the unemployment rate in the region is mandatory to obtain a clearer picture of the region’s employment situation. The employment-to-population ratio reflects “the share of people with work amongst the working age population. *Id.* at 25. The region’s employment-to-population ratio is around 66 percent. *Id.* at 61. The report notes that while this rate is high for a developing region, the numbers do not reflect the quality or conditions of employment. *Id.* Nor does the rate reflect those who are employed but are the working poor. See discussion *infra* note 133. Different reasons factor into why poverty has not been more effectively resolved. *Id.* One factor is the low population growth rate, which currently is at 4 percent. *Id.* To effectively reduce poverty a growth rate of 7 percent is needed. *Id.* A second factor has been “low labor absorption in the growth sectors.” *Id.* Opportunities for actual or sustained employment oftentimes do not arise and income security dominates the market. *Id.* A third factor involves “the inequality in the distribution of opportunities created by economic growth.” *Id.*

¹³⁵ WORLD EMPLOYMENT REPORT, *supra* note 8, at 61. The percentage change for labor productivity in sub-Saharan Africa between 1993 and 2003 was -1.5 whereas all other regions had a positive change. *Id.* at 28. The global percentage change was 10.0 percent. *Id.* Similarly, the annual productivity growth between 1993 and 2003 in sub-Saharan Africa

while global labor productivity increased by almost 11 percent.¹³⁶ In many instances, unemployment rates are disguised by the high proportion of the working poor and discouraged workers.¹³⁷ “Sub-Saharan Africa [also] has the highest incidence of working poverty of all developing regions.”¹³⁸ Roughly 110 million Africans earn below the poverty wage, unable to provide for their families even though they are considered employed.¹³⁹ Informal employment, generally a larger source of employment for women, accounted for 78 percent of sub-Saharan Africa’s nonagricultural employment, excluding South Africa.¹⁴⁰ Unemployment among employable youth also has been a serious problem in sub-Saharan Africa. In 2003, “the unemployment rate for youth ages 15-24 was twice that of the overall labor

was -0.2 whereas all other regions had a positive annual productivity rate. *Id.* Although the link between GDP and labor productivity are not definitively linked, the report states that “GDP growth is not identical with growth in labour productivity, but that the trends in these indicators usually move in the same direction.” *Id.* at 29.

¹³⁶ WORLD EMPLOYMENT REPORT, *supra* note 8, at 28. Labor productivity generally defined “is output, or value added, divided by the amount of labour used to generate the output.” *Id.* A decrease in labor productivity indicates that resources are being poorly allocated and misused. *Id.* On the other hand, an increase in labor productivity occurs “when value added rises through better use, coordination, etc. of all factors of production.” *Id.*

¹³⁷ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 7. In sub-Saharan Africa, the working poor account for almost 45 percent of total employment, and they are normally involved in the informal sector and agriculture. *Id.* 46 percent of the total population lives on less than \$1 per day, a percentage that exceeds any other developing region. *Id.* at 91. In addition, the level of poverty oftentimes continues for long and sustained intervals of time for individuals. *Id.* Between 1990 and 2003, about 55 percent of those who were employed were not earning enough to surpass the \$1 a day poverty line and less than 90 percent were not earning enough to surpass the \$2 a day poverty line. WORLD EMPLOYMENT REPORT, *supra* note 8, at 60. The “discouraged worker” refers to an individual of working age that drops out of the formal labor market due to unpromising employment prospects. MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 60–61. “Even though they want to work, these people do not actively seek work because they view job opportunities as limited, because they have restricted labour mobility or because they face discrimination or structural, social, or cultural barriers.” *Id.* More women than men are likely to be classified as a discouraged worker. *Id.* at 66.

¹³⁸ WORLD EMPLOYMENT REPORT, *supra* note 8, at 60.

¹³⁹ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 7.

¹⁴⁰ INT’L LABOUR ORG., WOMEN AND MEN IN THE INFORMAL ECONOMY: A STATISTICAL PICTURE 7 (2002), available at <http://www.ilo.org/public/english/employment/gems/download/women.pdf>. “Informal employment is comprised of both self-employment in informal enterprises (i.e. small and/or unregistered) and wage employment in informal jobs (i.e. without secure contracts, worker benefits, or social protection).” *Id.* Women generally comprise a larger proportion within the informal economy than do men. *Id.* at 8. Debate has revolved around whether informal employment is positive in that it is efficient and creative or negative, such as with social and economic development. *Id.* at 10.

force.”¹⁴¹ Compounding the unemployment problem is the lack of opportunities to produce goods or provide services, thus the correlation between poverty rates and unemployment has remained constant since the 1980s.¹⁴²

The impact of current armed conflicts and the devastation of previous conflicts present further challenges.¹⁴³ Almost half of all African nations have endured armed conflict since the end of the Cold War.¹⁴⁴ “[R]eduction in economic growth, increases on military expenditures, [and] deterioration in health status” due to civil wars continue to impair a post-conflict country and neighboring countries.¹⁴⁵ These costs can lower the GDP by 105 percent for the country directly affected and 115 percent for neighboring nations.¹⁴⁶ Additional military spending can lower the initial GDP of the directly affected country prior to the conflict by 250 percent.¹⁴⁷ The loss of lives is less easily calculated but likely more devastating, as well as the enduring impact on society and the economy of those displaced, wounded, maimed, or traumatized by armed conflicts.¹⁴⁸

Thus, the combination of poverty, unemployment, and war undoubtedly encumber efforts of local governments and institutions to focus or allocate resources to improve telecommunications access and ICT deployment. Yet, ICTs offer a viable means towards economic development and long-term sustainability that can alleviate these very pressures. For this reason, “[n]o longer are information and communications networks and services luxuries for developing countries—they are now a necessity.”¹⁴⁹

¹⁴¹ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 10.

¹⁴² *Id.* at 1. See generally Gustavo Crespi Tarantino, *Imputation, Estimation and Prediction Using the Key Indicators of the Labour Market (KILM)* (Int’l Labour Org., Employment Strategy Dept., Research Paper, 2003), available at <http://www.ilo.org/public/english/employment/strat/download/crespi.pdf>.

¹⁴³ Post-conflict reconstruction efforts focus on security, political transition, governance and participation, socio-economic development, human rights, justice and reconciliation, and coordination, management and resource mobilization. THE NEW P’SHIP FOR AFRICA’S DEV., AFRICAN POST-CONFLICT RECONSTRUCTION POLICY FRAMEWORK iv (2005), available at http://www.nepad.org/2005/aprmforum/PCRPolicyFramework_en.pdf.

¹⁴⁴ U.N. Econ. Comm’n For Africa, *Report of the Second Meeting on Human Development and Civil Society (CHDCS)* ¶ 31, U.N. Doc. ECA/DPMD/CHDCS/03/02 (May 26-27, 2003), available at http://www.uneca.org/chdcs/CHDCSII_final_report.pdf.

¹⁴⁵ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 38.

¹⁴⁶ *Id.*

¹⁴⁷ *Id.*

¹⁴⁸ THE NEW P’SHIP FOR AFRICA’S DEV., *supra* note 143, at 2.

¹⁴⁹ Pierre Guislan et al., *Connecting Sub-Saharan Africa: A World Group Strategy for Information and Communication Technology Sector Development* v (The World Bank, Working Paper No. 51, 2005), available at <http://event-africa-networking.web.cern.ch/event-africa-networking/cdrom/Worldbank/ConnectingSub-SaharanAfrica.pdf>.

Focus on developing the ICT sector has increased in Africa and among developing countries seeking “to diversify their economies, to respond to demand from developed countries for ICT-enabled services, to be less dependent on ICT goods and services imports, and to develop local human capabilities and generate job opportunities for the development of the information economy.”¹⁵⁰ Moreover, “[e]conomies are increasingly dependent on both the information that is available to them and the resources with which to use [that information].”¹⁵¹ Information is valued not only as a service or a good that can be bought or sold, but also for its ability to empower people and communities.¹⁵² Information and knowledge “are an essential input to innovation, knowledge creation, and social and political discourse.”¹⁵³ In sum, ICTs provide increased access to information and create economic opportunities. Many developing nations have come to realize, however, that this potential and reality do not come without their costs.

*1. Accessing New Opportunities for Business, Diversifying Economies*¹⁵⁴

Increasing business among small and medium-sized enterprises (“SMEs”) is a key component for future growth to bolster and increase exports and local competitiveness.¹⁵⁵ E-business practices have been widely adopted and reinforce global production and distribution that emphasizes cooperation and accelerated exchange of information.¹⁵⁶ Competitiveness and access into the global economy require companies to increasingly utilize ICTs.¹⁵⁷

ICTs benefit SMEs by accelerating communication and enhancing the efficiency of the management of information through computer networks and shared electronic files.¹⁵⁸ Successful and widespread use of ICTs can bring about a factor price equalization effect by allowing developing nations to

¹⁵⁰ *Information Economy Report 2006*, *supra* note 13, at 137-38.

¹⁵¹ *E-Commerce and Development Report*, *supra* note 1, at 103. The Internet can provide information about employment opportunities as well as online training opportunities. Educational facilities, health care, and businesses can have information delivered faster and more efficiently. *Id.* at 95.

¹⁵² The value of information does not diminish as its use increases, because the “nature of information and structure of the Internet foster knowledge sharing and communications.” Cukor & McKnight, *supra* note 13, at 52.

¹⁵³ El-Ghannam, *supra* note 125, at 49.

¹⁵⁴ Guislan et al., *supra* note 149, at v.

¹⁵⁵ Shahid Yusuf, *Globlisation and the Challenge for Developing Countries*, 12 J. AFRICAN ECONOMIES. 35, 57 (2003).

¹⁵⁶ *Information Economy Report 2006*, *supra* note 13, at xxvi.

¹⁵⁷ *Id.*

¹⁵⁸ ORG. OF ECON. CO-OPERATION & DEV., ICT, E-BUSINESS, AND SMES 9 (2004) [hereinafter ICT, E-BUSINESS, AND SMES], available at <http://www.oecd.org/dataoecd/32/28/34228733.pdf>.

compete in international markets.¹⁵⁹ Certain economic theories argue that “long-run equilibrium arising from international trade will result in equalizing the wage rates in industrialized (high-wage) and developing (low-wage) countries.”¹⁶⁰ Thus, to varying degrees, ICTs not only create new opportunities but also level existing barriers to competition.

The Internet in particular has lowered entry barriers for SMEs that once found it too expensive to compete with larger, more established international producers, and has expanded options for communicating with other businesses, customers, suppliers, and employees.¹⁶¹ Because of its “open structure, standardized technology, and uncontrolled and uncensored content, [the Internet] is a unique and ubiquitous tool of knowledge and information sharing.”¹⁶² Market possibilities have multiplied for SMEs, whose success depends on combining entrepreneurship with innovation, entering rapidly growing industries, and participating in a network of co-operative alliances.¹⁶³ Niche markets can be targeted efficiently due to reductions in transaction costs and search costs, allowing more resources to be dedicated to creating and tracking customer profiles and strengthening consumer relations.¹⁶⁴ Advertising on the Internet also markets the company to a larger and more diverse group of consumers.¹⁶⁵ Moreover, the ability to de-

¹⁵⁹ Mansell, *supra* note 103, at 284. The factor price equalization effect, an economic theory set forth by Paul A. Samuelson, states that “under certain restrictive assumptions the international exchange of goods results in the international equalization of factor remunerations.” JURG NIEHANS, A HISTORY OF ECONOMIC THEORY: CLASSIC CONTRIBUTIONS, 1720-1980 428 (1990).

¹⁶⁰ Mansell, *supra* note 103, at 284.

¹⁶¹ Yusuf, *supra* note 155, at 57. For many developing countries, “the initial impact of the Internet [is] on trade, information and technology transfer.” *Id.* at 56. Besides advantaging small and medium-sized enterprises (“SMEs”), the Internet can be “a cheap and convenient source of information on market demand, a mechanism for securing contracts, for servicing clients, for purchasing items and for increasing the efficiency of the sales and payment process” for producers in developing nations. *Id.* at 56-57.

¹⁶² Cukor & McKnight, *supra* note 13, at 52. Access to information and the Internet provides a wider option of possibilities to accomplish goals and objectives, both personal and professional. *Id.* For example, ICTs can broaden economic and cultural opportunities when utilized and adapted to fit the local needs of the community. *Id.* at 47.

¹⁶³ Yusuf, *supra* note 155, at 57. “[T]he synergy [is] derived from their links with large firms and, because of globalization, their widening role on the international trade arena.” *Id.*

¹⁶⁴ ORG. OF ECON. CO-OPERATION & DEV., THE ECONOMIC AND SOCIAL IMPACT OF ELECTRONIC COMMERCE: PRELIMINARY FINDINGS AND RESEARCH AGENDA 20 (1999), available at <http://www.oecd.org/dataoecd/3/12/1944883.pdf>.

¹⁶⁵ *Id.* “Marketing and advertising is the sector that is most affected by the use of the Web.” *Id.* at 97. For example, “[f]or suppliers, Web advertising offers the ability to target and deliver delivered messages to an audience with specific demographics and interests; and the ability to collect, track, analyse, and leverage consumer behaviour/buying patterns facilitates the growth of online marketing.” *Id.* See also *id.* at 50 (discussing how marketing products to a broader base of consumers can be done at lower costs through the Internet); *id.* at 60 (discussing how e-commerce lowers transactions costs and costs to bring in new

liver services online rather than through a physical presence “allows developing countries to benefit from their comparative advantage in some ICT-enabled labour-intensive services.”¹⁶⁶ Unfortunately, ICT and Internet usage is often limited to the owner or managers of an enterprise, thus “little has been done to take full advantage of the opportunities offered by the new technologies.”¹⁶⁷ Enabling widespread access to more users through technologies like WiMAX can help broaden the reach of the benefits of ICTs among SMEs.

2. *Networking, Learning, and Developing Better Ways to Reach Students*¹⁶⁸

ICTs also broaden educational opportunities.¹⁶⁹ Students at the Mbita Point primary school in Kenya, for example, use hand-held devices connected to a base station at the school and then to a satellite to receive up-to-date textbook information.¹⁷⁰ ICTs aside, investment in education is highly

consumers since “advertising is typically cheaper [online] than for other media and more targeted.”).

¹⁶⁶ *E-Commerce and Development Report*, *supra* note 1, at 19. Currently in Africa and Asia, for example, SMEs are connecting the Internet to communicate with suppliers and customers, thus reducing costs while increasing efficiency. *Id.* at xx.

¹⁶⁷ *Id.* Additional perceived barriers include lack of network security as well as slow and unstable connections. *Id.*

¹⁶⁸ Guislan et al., *supra* note 149, at v.

¹⁶⁹ *E-Commerce and Development Report*, *supra* note 1, at 95. Education plays a key role for development in many nations because it helps to “reduce social disparities and promote sustainable economic growth.” *Id.* at 97. The opportunities provided by ICTs “to change the context of and approach to learning as well as to extend the reach of educational institutions could have a profound effect on development.” *Id.* at 95. Promoting successful online education, however, entails addressing two main legal concerns: accreditation and recognition, and intellectual property rights. *Id.* at 119. Accreditation systems, weak and ineffective in many developing countries, are of particular concern because “[w]hile learning for its own sake has cultural value and in some circumstances can be viewed as leisure activity, in economic terms it is accredited and certified qualifications that count.” *Id.* “[A]ccredited institutions ensure and promote quality in higher education, support the transferability of degrees across states, regions or nations and guarantee the authenticity of a degree.” *Id.* Building a strong brand name for the university and increasing recognition is also crucial since “[d]eveloping countries in particular suffer from poor recognition of their degrees . . .” *Id.* at 120. Intellectual property rights are particularly troubling because the lack of an enforceable rights regime deters “innovation by limiting free access to information.” *Id.* As a result, “economic policy has long supported the need to grant temporary property rights to innovators so as to enable a return on their investments and thus encourage them to continue innovating, thereby contributing to a society in general.” *Id.* Other legal concerns exist, including “recognition of titles . . . curriculum design, and standardization of teachers’ qualifications” in addition to reforms necessary within “commercial law, security and authentication, electronic payments systems, consumer protection, applicable law, and fiscal and custom regulations.” *Id.* at 119.

¹⁷⁰ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 190. The efforts of different organizations have successfully provided innovative educational tools at low-cost measures. One such initiative was begun by a non-profit associa-

valued. They simultaneously benefit students and the local and regional communities; the increased amounts of available knowledge and numbers of trained professionals and technicians inadvertently and directly advantage attempts towards economic development.¹⁷¹ Improving educational curriculum programs on a long-term basis has also correspondingly accelerated other educational sectors, like corporate training, higher education, and language training.¹⁷²

Applying ICTs to education has allowed “for the unbundling of academic functions, which in turn promotes international trade in educational services by fostering specialization and customization of education services.”¹⁷³ The Internet in particular has had a significant impact. It facilitates increasing the distribution of educational materials and resources as well as enhancing research, publication, and networking opportunities.¹⁷⁴ Moreover, the Internet increases “trade in higher education services by facilitating the reuse and reselling of higher education resources to serve the life-long learning needs of the information society.”¹⁷⁵ It also has positively impacted research and development.¹⁷⁶ Educational institutions in developing nations continue to seek information about online education, its possible role in educational programs, and ways and strategies to provide online higher education to more students.¹⁷⁷ Online education has received increased attention for its ability to help bridge educational gaps and also to promote domestically produced content for local use as well as export abroad.¹⁷⁸

tion, One Laptop Per Child (“OLPC”). See One Laptop Per Child, <http://laptop.org/> (last visited Mar. 27, 2007). OLPC is working to develop and deploy a low-cost laptop to provide a vital educational tool “for the world’s poorest children living in its most remote environments.” *Id.* The expected cost for the laptop is \$100. One Laptop Per Child, OLP-CWiki, http://wiki.laptop.org/go/One_Laptop_per_Child (last visited Mar. 27, 2007). Although the price will be lower than any other laptop on the market, OLPC remains dedicated to providing more with less in terms of software, hardware, and distribution. *Id.* The laptop can be used as an ebook reader, for example, and “roughly 500 children should be able to share a single point of back haul to the Internet.” *Id.* In addition, because many children that will be using the laptop will not have access to electricity, OLPC is working to integrate ways to power the laptop by human power, such as cranking “where one minute of cranking [can] give you ten minutes of use.” *Id.* The expected cost for the laptop is \$100. *Id.*

¹⁷¹ *E-Commerce and Development Report*, *supra* note 1, at 97.

¹⁷² *Id.* at 109.

¹⁷³ *Id.*

¹⁷⁴ *Id.* at 115–18.

¹⁷⁵ *Id.*

¹⁷⁶ *Id.* at 116.

¹⁷⁷ *Id.* at 95. Students in India, for example, have been able to obtain a bachelor’s degree online from the Indira Gandhi Open University (“IGNOU”), with some of the content used by the university is being brought from a provider in the United Kingdom. *Id.* at xxiii.

¹⁷⁸ *E-Commerce and Development Report*, *supra* note 1, at 103. Six key factors can assist “the current adoption and promotion of online higher education in developing countries.” *Id.* at 101. The six factors are 1) develop educational capacity; 2) improve the quality

3. Health and Medical Providers Posting Vital Information through ICTs

Sub-Saharan Africa is “staggering under the highest infectious disease burden in the world (25 percent), [while retaining] only 1.3 per cent of the world’s health care practitioners.”¹⁷⁹ To compensate for the personnel shortfall, health and medical institutions have begun seeking alternatives to provide vital information on health and medical care. ICTs provide “efficient channels” to provide health-care treatment and services.¹⁸⁰ Just as ICTs have benefited SMEs by accelerating communication and enhancing the efficient management of information through computer networks and shared electronic files, ICTs have likewise enhanced the efficiency of tracking and managing data on diseases and patient files.¹⁸¹

The Treatment and Research AIDS Center (“TRAC”) in Rwanda, “the primary agency responsible for national coordination of clinical treatment for persons living with HIV/AIDS,”¹⁸² has taken advantage of cellular phone technology to assist in their efforts. TRAC instructs trainers and supervisors how to treat and care for persons living with HIV/AIDS and related diseases.¹⁸³ It is also responsible for developing curriculum and programs on the national level that instruct how to care for patients with HIV/AIDS.¹⁸⁴ TRAC, with assistance from the United States Centers for Disease Control and Prevention, has also created TRACnet, “a nationwide internet/cellular/landline information system which uses the mobile network to extend coverage out to every participating clinic in the nation.”¹⁸⁵ Another initiative, the Multilateral Initiative on Malaria Communications Network (“MIMCom”), connects African scientists and malaria researchers with each other.¹⁸⁶ The MIMCom network currently connects 19 sites

of learning; 3) increase access to higher education; 4) raise revenue; 5) expand the adoption of ICT skills and infrastructure to generate a knowledge-based economy; and 6) acknowledge and utilize online higher education as a tool for survival and marketing strategy. *Id.* at 101-03.

¹⁷⁹ U.N. POPULATION FUND, STATE OF WORLD POPULATION 2005: A PASSAGE TO HOPE: WOMEN AND INTERNATIONAL MIGRATION 7 (2006), available at http://www.unfpa.org/swp/2006/pdf/en_sowp06.pdf.

¹⁸⁰ *Information Economy Report 2005*, *supra* 125, at xvii.

¹⁸¹ ICT, E-BUSINESS, AND SMES, *supra* 158, at 9.

¹⁸² TRAC, http://www.tracrwanda.org.rw/Units_functions.HTML (last visited Mar. 27, 2007).

¹⁸³ *Id.*

¹⁸⁴ *Id.*

¹⁸⁵ Jonathan Donner, *User-Led Innovations in Mobile Use in Sub-Saharan Africa*, RECEIVER, 4-5, 2005, available at http://www.receiver.vodafone.com/14/articles/pdf/14_02.pdf. This system “allows clinics and managers to exchange information in real-time, using voice-prompts and a toll-free number donated by Rwanda’s landline and mobile carriers.” *Id.* at 5.

¹⁸⁶ STEINER, et al., *supra* note 4, at 25. Countries within this network include Kenya, Uganda, Cameroon, Malawi, Mozambique, Ghana, Ethiopia, Burkina Faso, Gabon, and Tanzania. *Id.*

in 12 countries¹⁸⁷ and is regularly used by researchers and staff for research purposes, accessing databases, searching for grant opportunities as well as teleconferencing or taking online classes.¹⁸⁸ Online accessibility provided by MIMCom has had an affirmative impact both on the researchers' abilities to share more data at faster rates as well as their ability to "compete favorably with their colleagues in other parts of the world in proposal writing, acquisition of literature, and submission of papers for publication."¹⁸⁹

Of the many projects The African Medical and Research Foundation ("AMREF") embarks upon each year, one project is aiming to introduce and implement ICTs to provide telemedicine and improve clinical outreach programs.¹⁹⁰ To achieve this objective, AMREF is working to establish a regional "health intranet."¹⁹¹ Once completed, the health intranet will connect "rural healthcare facilities to academic medical centers" that will allow the facilities to obtain medical information once formerly inaccessible.¹⁹² In addition, the Telemedicine Outreach Pilot Project ("TOPP") seeks to allow rural healthcare providers online access to current medical knowledge and to offer the benefits of outreach services to rural hospitals.¹⁹³ So far, TOPP has succeeded in improving patient lists and supplies, and has provided tele-consultation services "including written consultation requests with relevant patient information, x-ray images, and photographs of the patient's condition."¹⁹⁴ Increased access to basics like email guarantees the delivery of laboratory reports to AMREF doctors and health care specialists; newly available training materials and research papers from abroad can easily be acquired online.¹⁹⁵ In addition, TOPP is working to deploy a virtual consulting center once virtual teleconferencing consultations con-

¹⁸⁷ Julia Royall, et al., *Crossing the Digital Divide: The Contribution of Information Technology to the Professional Performance of Malaria Researches in Africa*, 5 AFR. HEALTH SCI. 246, 247 (2005).

¹⁸⁸ *Id.* at 249–50.

¹⁸⁹ *Id.* at 252.

¹⁹⁰ AMFREF, What We Do – Projects – Telemedicine Outreach Program, <http://www.amref.org/index.asp?PageID=63&ProjectID=94&PiaID=3&CountryID=1> (last visited Mar. 27, 2007) [hereinafter Telemedicine Outreach Project].

¹⁹¹ AMFREF, What We Do – Projects – Telemedicine, <http://www.amref.org/index.asp?PageID=63&ProjectID=39> (last visited Mar. 27, 2007) [hereinafter AMREF Projects]. The African Medical and Research Foundation ("AMREF") is an international health development organization aiming "to improve the health of disadvantaged people in Africa." AMREF, Who We Are, <http://www.amref.org/index.asp?PageID=9> (last visited Mar. 27, 2007) AMREF's six targeted areas of improvement are HIV/AIDS, tuberculosis and sexually transmitted diseases; malaria; safe water and sanitation; family health; clinical services, disaster management and emergency response; training and health learning materials. *Id.*

¹⁹² AMREF Projects, *supra* note 191.

¹⁹³ Telemedicine Outreach Project, *supra* note 190.

¹⁹⁴ *Id.*

¹⁹⁵ *Id.*

nections are established.¹⁹⁶ Patient records will be saved into a single database and accessible in more remote or rural hospitals in East Africa.¹⁹⁷

Thus, ICTs can play a significant role in fostering economic development and provide opportunities for employment, business, education, health, and beyond. Despite the significant role ICTs can have in fostering economic development, the dilemma is that they only provide one of the means necessary to foster long-term growth and sustainability. For immediate and long term economic growth, as well as successful adjustment into the global economy, reinforcement between “capital accumulation, technological progress, financial depth and structural change” must occur.¹⁹⁸

IV. CHALLENGES AND BARRIERS TO CONNECTIVITY

Despite the potential ICTs have to offer, usage of ICTs and their deployment in sub-Saharan Africa have remained limited. Although the number has doubled since 2000, Africa has the fewest number of regional Internet users.¹⁹⁹ In 2001, only one African in 160 used the Internet.²⁰⁰ Of the total users in 2002, “North Africa and South Africa [were] responsible for 1.2 million, leaving about 500,000 for the remaining 49 Sub-Saharan African countries.”²⁰¹ This is an extremely low figure, considering that the sub-Saharan population at the time was roughly 687 million.²⁰² By the middle of 2002, the number of dial-up²⁰³ Internet users approximated 1.7 million, still representing less than 1 percent of the total sub-Saharan population.²⁰⁴ Only 1.1 percent of the entire African population in 2003 had Internet access, whether dial-up or broadband, to the Internet.²⁰⁵ The penetration rate for broadband is less than 1 percent in most African countries,

¹⁹⁶ AMREF Projects, *supra* note 191.

¹⁹⁷ *Id.*

¹⁹⁸ U.N. Conference On Trade & Dev., Div. for Serv. Infrastructure Dev. & Trade Efficiency, *Economic Development in Africa: Rethinking the Role of Foreign Direct Investment*, 24, U.N. DOC. UNCTAD/GDS/AFRICA/2005/1 (2005) [hereinafter *Rethinking the Role of Foreign Direct Investment*], available at <http://www.globalpolicy.org/socecon/ffd/fdi/2005/unctadreport.pdf>.

¹⁹⁹ *E-Commerce and Development Report*, *supra* note 1, at 34.

²⁰⁰ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note at 3, at 252.

²⁰¹ African Internet Infrastructure Information – A Status Report (2002), <http://www3.sn.apc.org/africa/afstat.htm>. The report notes that exact statistical figures are difficult to obtain due to the large number of shared accounts and the high use of public access services. *Id.* Other statistics show that one in thirteen had a TV and one in thirty-five owned a cellular phone. *Id.*

²⁰² Guislan et al., *supra* note 149, at 41.

²⁰³ Dial-up connections use standard copper wire telephone networks. THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES, *supra* note 27, at 120.

²⁰⁴ African Internet Infrastructure Information – A Status Report, *supra* note 201.

²⁰⁵ *Information Economy Report 2005*, *supra* note 125, at xv.

“even in those countries that are more advanced in ICT, such as South Africa, Mauritius, Egypt and Tunisia.”²⁰⁶

For those without access, ICTs have been implemented in a limited fashion. Some SMEs and other enterprises use wireless technologies and ICTs, but use has not been widespread. In 2002, only a few firms in Uganda were functioning at an advanced level of e-business, with most only using the Internet for e-mail.²⁰⁷ A 2001 survey also found businesses in Senegal using ICTs in a limited manner.²⁰⁸ A 2002 survey of 105 SMEs and microenterprises in Nigeria revealed that more than one third did not use any ICTs.²⁰⁹ Lack of an e-commerce regulatory framework and adequate infrastructure in Mozambique, for example, was identified as “an impediment in the development of e-businesses.”²¹⁰

Barriers to increased ICT deployment persist across sub-Saharan Africa. The ability to deliver the infrastructure and technologies necessary to achieve affordable costs for connectivity is often elusive. Inadequate telecommunications infrastructures and insufficient access to computers are two of the most significant barriers.²¹¹

A. Lowering the Barriers

1. Minimal Access to Computers

Costs to lay landlines, equipment, purchase computers, and obtain licensing have inhibited network expansion in Africa.²¹² But the lack of widespread ownership of or access to personal computers exacerbates the problem: it is difficult to justify, much less recoup, network infrastructure outlays when only one in 130 Africans owns a computer.²¹³ Each computer with an Internet connection generally can support only a range of three to five users, and connectivity costs can be high.²¹⁴ In 2005, the average per-

²⁰⁶ *Id.* at 9.

²⁰⁷ *E-Commerce and Development Report*, *supra* note 1, at 36.

²⁰⁸ *Id.* at 35.

²⁰⁹ *Id.* at 36. Limited skill levels were found to be “a key factor for low ICT usage.” *Id.* Firms whose managers had a lower academic qualifications largely did not use ICTs while firms adopting higher usage and levels of e-business “were all run by managers with an engineering background, and had more skilled employees (engineers and graduate degree holders) among the workforce.” *Id.*

²¹⁰ *Id.* at 34.

²¹¹ Jennifer Myers, *Human Rights and Development: Using Advanced Technology to Promote Human Rights in Sub-Saharan Africa*, 30 CASE W. RES. J. INT’L LAW. 343, 358 (1998).

²¹² *See generally* African Internet Infrastructure Information – A Status Report, *supra* note 201.

²¹³ *Id.*

²¹⁴ *Id.* Aggravating the problem even more is the lack of electricity needed to turn on the computers or keep them on due to power outages, blackouts, or no power at all. MEETING

sonal computer ownership in less developed countries was three out of every 1,000 people.²¹⁵ The highest ownership rate was in Senegal, where an average of eleven people per 1,000 owned a computer.²¹⁶ Not coincidentally, public Internet access services are increasingly in high demand, especially in urban areas, as few individuals are able to afford private telephone lines or computers.²¹⁷

Telecommunications operators in developing nations have been “extremely cost sensitive due to the low average revenue per user compared with developed countries.”²¹⁸ Fewer personal computers corresponds to fewer potential customers for telecommunications services, and thus a smaller base of consumers from which to recoup deployment costs. This “translates to price pressure on equipment both in terms of acquisition and operating costs.”²¹⁹ Nevertheless, suppliers of equipment and services have adapted to some extent to address the needs of their customers.²²⁰ Due to the fact that the basic structures are relatively inflexible, however, suppliers have been unable to successfully adapt to more advanced applications in accordance with their customers’ rising demands.²²¹

2. Limited Infrastructure and Costs of Connectivity

Telecommunications in sub-Saharan Africa is limited and expensive.²²² Sub-Saharan Africa comprised 10 percent of the world’s population in 2002, yet only contained 0.2 percent “of the world’s one billion telephone

THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 251–52. SMEs are affected the most due to the fact that “[p]ublic utilities provide most electric power in Sub-Saharan Africa—inefficiently, at high cost and with a low degree of reliability.” *Id.* at 252. Power outages occurred 89 days out of the year in 1998 in Uganda. *Id.* at 251. For businesses investing in a generator as a back-up or main power supply, the costs for fuel to keep the generator running has a high financial toll. *Id.* at 252.

²¹⁵ El-Ghannam, *supra* note 125, at 45. In categorizing countries as more developed, moderate developed or less developed, the author utilized data from the 2002 Human Development Report *Id.* at 42. Countries in the less developed category were Madagascar, Sudan, Nepal, Togo, Bangladesh, Mauritania, Yemen, Djibouti, Nigeria, Congo, Zambia, Ivory Coast, Tanzania, Benin, Uganda, Senegal, Angola, Gambia, Guinea, Malawi, Rwanda, Mali, Central Africa Republic, Chad, Mozambique, Guinea Bissau, Burundi, Ethiopia, Buskina Faso, Eritria, Niger, and Sierra Leone. *Id.* at 53.

²¹⁶ *Id.* at 45. In comparison to other countries in different regions, the percentage for computer penetration in China was 2.7 percent and 0.7 percent in India. *Information Economy Report 2005*, *supra* note 125, at xvii.

²¹⁷ African Internet Infrastructure Information – A Status Report, *supra* note 201.

²¹⁸ Richard Mumford, *Microwaves in Europe: Markets and Technologies*, 49 *MICROWAVE JOURNAL* 80, 98 (2006) (quoting Wolfgang Bosch, CTO of Filtronic, a leading manufacturer of microwave technologies).

²¹⁹ *Id.*

²²⁰ Tanya L. Yarbrough, *Connecting the World: The Development of the Global Information Infrastructure*, 53 *FED. COMM. L.J.* 315, 332 (2001).

²²¹ *Id.*

²²² Guislan et al., *supra* note 149, at 29.

lines.”²²³ In fact, only 5.8 percent of the total sub-Saharan population, excluding South Africa, had telephones in 2002.²²⁴ The fixed line network in nations like Nigeria, for instance, is sparse and unreliable, and has impeded Internet use in the country.²²⁵

Limited infrastructures and minimal availability of bandwidth make Internet access expensive and stunt growth for Internet access penetration.²²⁶ Moreover, “the region has the lowest capacity in the world for international Internet bandwidth.”²²⁷ Even so, “every square inch of Africa is [currently] covered by satellite bandwidth.”²²⁸ Satellite bandwidth, however, is inferior in quality and also more expensive than wireless options.²²⁹ This is because “[a]ll upstream inter-continental transmission capacity is provided by either submarine fibre or satellite [while] intra-regional connectivity is provided by cross-border fibre or by microwave and/or satellite links.”²³⁰ Fiber optics,²³¹ although preferable due to greater data transfer capacities and lower costs, are infrequently deployed and used in Africa.²³² The western coast of Africa has several fiber Internet access points; the eastern coast has none.²³³ Plans are underway through the Eastern African Submarine System (“EASSy”) project to connect East Africa to Asia via an 8,000 kilometer cable.²³⁴

Prices for Internet access and connection in Africa are high. In 2002, the average total cost for twenty hours of local dial-up Internet access was about \$60 per month.²³⁵ For sub-Saharan Africans, nearly fifty percent of whom survive on less than \$1 per day,²³⁶ such costs are astronomical. Bandwidth prices in Africa and other developing nations can be 100 times

²²³ African Internet Infrastructure Information – A Status Report, *supra* note 201.

²²⁴ Guislan et al., *supra* note 149, at 5. This is an increase from 1990, where “the number of telephones per capita” was 1%. *Id.*

²²⁵ African Internet Infrastructure Information – A Status Report, *supra* note 201.

²²⁶ Guislan et al., *supra* note 149, at 29.

²²⁷ *Id.*

²²⁸ STEINER ET AL., *supra* note 4, at 69. “By November 2003, thirteen satellite operators had 51 satellites deployed with coverage over Africa.” *Id.*

²²⁹ The Int’l Dev. Research Ctr., *Viewpoint: Bandwidth Can Bring African Universities up to Speed*, Jul. 5, 2005, http://www.idrc.ca/en/ev-84498-201-1-DO_TOPIC.html [hereinafter *Bandwidth Can Bring African Universities up to Speed*].

²³⁰ STEINER ET AL., *supra* note 4, at 69.

²³¹ “Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers about the diameter of a human hair” and transfers data at speeds faster than cable or DSL. HIGH-SPEED INTERNET ACCESS—“BROADBAND”, *supra* note 18, at 2.

²³² *Bandwidth Can Bring African Universities up to Speed*, *supra* note 229.

²³³ *The Digital Divide Report*, *supra* note 2, at 37.

²³⁴ *Id.*

²³⁵ African Internet Infrastructure Information – A Status Report, *supra* note 201.

²³⁶ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 91.

more expensive than in developed nations.²³⁷ The most common factors contributing to such high prices are poor infrastructure and modest to no competition in the market.²³⁸ The average African university, for example, pays more than 50 times for the same bandwidth than do universities in North America or Europe.²³⁹

Alongside expensive bandwidth costs are the significant variations in costs throughout one region. Restrictions that affect the requirements in order to connect internationally, like requiring ISPs to use an international gateway, contribute to the wide differences in bandwidth costs that can vary from one country to the next.²⁴⁰ While the international component of backbone connectivity is only a small part of the total operating cost for ISPs, the removal of such restrictions has reduced connectivity costs and accelerated infrastructure development in some developing nations.²⁴¹ This has resolved partially the concern that local and regional ISP operators in developing nations oftentimes must pay the entire cost for connections made between their networks and the global ISP's network, despite the fact that information is carried in both directions.²⁴²

Additional problems that exist due to poor and limited infrastructure include highly unreliable quality of service. Businesses in Madagascar, for example, often have several phone lines because it is difficult to determine whether any of them will work.²⁴³ Network capacity also is problematic. Even countries with universally available telecommunications services experience a drop in quality of service due to network capacity constraints brought by increasing number of users.²⁴⁴ Another factor is the inability to

²³⁷ *Information Economy Report 2005*, *supra* note 125, at 100.

²³⁸ *Id.*

²³⁹ *Bandwidth Can Bring African Universities up to Speed*, *supra* note 229. Ideally, bandwidth suited for most universities is fiber optic cable because it is faster, cheaper, and has the ability to transfer larger amounts of data when compared to other methods. *Id.*

²⁴⁰ *Information Economy Report 2005*, *supra* note 125, at 101.

²⁴¹ *Id.* The backbone of a network, which can be wired or wireless, is the "central part of a large network to which two or more subnetworks link . . . [and] is the primary path for data transmission." THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES, *supra* note 27, at 120. Backbone networks consist of cables, radio links, nodes and hubs which create the Internet's infrastructure for a network. STEINER ET AL., *supra* note 4, at xxvii. They have currently come to mean the central physical infrastructure that carries IP traffic. *Information Economy Report 2005*, *supra* note 125, at 93. At least three factors have been identified for ensuring and increasing accessibility to ICTs in developing nations - backbone networks, access services, and equipment and services. Yarbrough, *supra* note 220, at 331. The inability to ensure a working ICT network including at least these three factors has led to either reduced quality of service or users unable to connect to the Internet except through limited means or resources. See *Information Economy Report 2005*, *supra* note 125, at 108.

²⁴² *Information Economy Report 2005*, *supra* note 125, at 89.

²⁴³ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 252-53.

²⁴⁴ Yarbrough, *supra* note 220, at 331.

sustain certain applications that require a larger proportion of the transmission capacity within telephone networks.²⁴⁵

Several efforts have begun to address the issue of connectivity costs. The African Internet Service Providers Association (“AfrISPA”) has formulated the Halfway Proposition, an initiative designed to address the fundamental causes that have led to expensive connectivity costs in Africa.²⁴⁶ Presented at the 2002 Conference of African Ministers of Finance and Development, the Halfway Proposition advocates alleviating the burdens that have existed for African ISPs in obtaining international connectivity and proposes creating traffic aggregation points.²⁴⁷ The creation of these points would require the development of National Internet Exchange Points (“IXPs”) throughout Africa and the emergence of Regional Carriers to interconnect with these Exchange Points.²⁴⁸ National IXPs are envisioned as the halfway step toward the eventual establishment of regional IXPs.²⁴⁹ Under the plan, state regulators would be required to assure that backbone transmission networks were available wherever connectivity is required.²⁵⁰ As a result of implementation of the Halfway Proposition, Johannesburg, South Africa; Nairobi, Kenya; Maputo, Mozambique; Kinshasa, Democratic Republic of Congo; Ibadan, Nigeria; Dar es Salaam, Tanzania; Kampala, Uganda; Mbabane, Swaziland; and Kigali, Rwanda now have IXPs.²⁵¹ Thus, the creation of a regional network infrastructure through IXPs, although slow, is underway. Nations with local and regional IXPs are able to aggregate more traffic, thus increasing the capability for users to utilize the network and providing more incentive for global backbone networks to interconnect with African IXPs.²⁵²

²⁴⁵ *Id.*

²⁴⁶ *Information Economy Report 2005*, *supra* note 125, at 108.

²⁴⁷ *Id.*

²⁴⁸ AFR. INTERNET SERV. PROVIDERS ASS’N (“AfrISPA”), HALFWAY PROPOSITION, *Halfway Proposition*, 4 (Oct. 2002) [hereinafter AfrISPA HALFWAY PROPOSITION], available at http://www.afrispa.org/HalfwayDocs/HalfwayProposition_Draft4.pdf. ISPs such as Africa Online provide pan-African access. Africa Online is the largest Pan-African ISP in sub-Saharan Africa and offers a wide range of services and operates in Cote d’Ivoire, Ghana, Kenya, Namibia, Swaziland, Tanzania, Uganda and Zimbabwe. Africa Online, <http://www.africaonline.com/> (last visited Mar. 27, 2007). See generally Int’l Telecomm. Union, *Via Africa: Creating Local and Regional IXPs to Save Money and Bandwidth*, (2005), available at <http://www.itu.int/ITU-D/treg/publications/AfricaIXPRep.pdf>.

²⁴⁹ See *Information Economy Report 2005*, *supra* note 125, at 108.

²⁵⁰ AfrISPA HALFWAY PROPOSITION, *supra* 248, at 6.

²⁵¹ Afr. Internet Serv. Providers Ass’n, African IXPs, http://www.afrispa.org/african_ixps.htm (last visited Mar. 27, 2007).

²⁵² *Information Economy Report 2005*, *supra* note 125, at 103.

B. Identifying and Resolving the Setbacks

African governments are aware that without cooperative and integrated regional efforts, access to ICTs will remain as unobtainable as it was in the past. In its 2004 strategic plan, the African Union Commission²⁵³ was emphatic that ICTs play a role in economic and social development.²⁵⁴ However, “unless Africa takes the necessary counter measures,” the digital divide and gap between industrialized and developing nations threatens to widen, leaving many African nations in danger of isolation.²⁵⁵ ICTs can “reduce the digital gap within African countries and promote development of the African content in the global network.”²⁵⁶

Regulatory reforms and regional initiatives over the past few years have allowed the telecommunications sector in Africa to make some headway,²⁵⁷ even though the level of telecommunications technologies’ penetration is negligible when compared with other developing regions.²⁵⁸ Telecommunications service coverage has grown from 6.9 subscribers per 1,000 people in 1975 to 61.9 per 1,000 in 2003, a nearly ten-fold increase.²⁵⁹ In addition, telecommunications innovations are aiding the improvement of other local infrastructure such as roads.²⁶⁰ Value-added services,²⁶¹ such as “on-line data processing, on-line data base storage and retrieval, electronic data

²⁵³ The African Union (“AU”), established in 1999, has 53 member states. The objectives of the AU include accelerating socio-economic development, coordinating the objectives and goals of the member states to create a stronger unity throughout the continent, and promoting peace and security. African Union, *African Union In A Nutshell*, http://www.africa-union.org/root/au/AboutAu/au_in_a_nutshell_en.htm (last visited Mar. 27, 2007).

²⁵⁴ AFRICAN UNION COMM’N, STRATEGIC PLAN OF THE AFRICAN UNION COMMISSION VOL. 1: VISION AND MISSION OF THE AFRICAN UNION 13, (2004), available at <http://www.africa-union.org/root/au/AboutAu/Vision/Volume1.pdf>.

²⁵⁵ *Id.*

²⁵⁶ *Id.* at 15.

²⁵⁷ Adlane Fellah, *WiMAX/BWA in Africa*, WIMAX.COM, June 15, 2005, http://www.wimax.com/commentary/spotlight/wimaxspotlight2005_06_15_part1 [hereinafter *WiMAX/BWA in Africa*]. Over the past few years “a wave of deregulations and the prioritization of the telecoms sector through pan-African initiatives . . . have boosted the creation of independent regulators and the entry into the market of competing services providers.” *Id.* See also discussion *infra* Part V.B.

²⁵⁸ Alexander Keck & Calvin Djiofack-Zebaze, *Telecommunications Services in Africa: The Impact of Multilateral Commitments and Unilateral Reform on Sector Performance and Economic Growth* 5 (The World Trade Org., Working Paper ERSD-2006-10,2006) (concluding that “more competition and better regulation lead to lower prices and improved availability of telecommunications services in the mobile and fixed-line segments both in Africa and globally.”).

²⁵⁹ CAPITAL FLOWS AND DEVELOPMENT FINANCING IN AFRICA, *supra* note 6, at 139–40.

²⁶⁰ *Id.* at 139.

²⁶¹ Value-added services or communications technologies “add value” to the consumer’s information “by enhancing its form or content or by providing for its storage and retrieval.” Keck & Djiofack-Zebaze, *supra* note 258, at 5.

interchange, email and voice mail,” have also increased as some governments open their telecommunications markets to competition and private investment.²⁶²

“[R]estrictive regulatory policies, state monopolies...and a shortage of local skills in information and communication technologies have been responsible for the slow development of African [telecommunications].”²⁶³ “Governance failure” and policy credibility keep the region from acquiring more foreign direct investment (“FDI”) than it has received in the past.²⁶⁴ Governments have traditionally been especially reluctant to relinquish ownership of utilities such as telecommunications to the private sector, and many governments continue to prefer the status quo, regardless of the costs and losses.²⁶⁵ However, privatization fosters a favorable environment for investment and competition while failure to liberalize state monopolies can hinder attempts for economic growth.²⁶⁶

The trend toward privatization of African state telecommunications monopolies to create more liberal market environments in African telecommunications has intensified in recent years.²⁶⁷ Competition among African telecommunications systems swelled around 2000, and by 2004 the region transformed from a system of monopoly-controlled regimes to less than half of the states maintaining monopolies.²⁶⁸ Avenues for foreign investment became available subsequent to states’ relinquishment of control over state-owned monopolies.²⁶⁹ Financing from abroad has resulted in further degrees of internal regulatory reforms in many countries, involving effec-

²⁶² *Id.*

²⁶³ *WiMAX/BWA in Africa*, *supra* note 257.

²⁶⁴ *Rethinking the Role of Foreign Direct Investment*, *supra* note 198, at 20–21.

²⁶⁵ Privatization is often fiercely resisted. Such skepticism may be a result “of an inherent distrust of the capitalist motive.” Leahy & O’Brien, *supra* note 105, at 14. It could also stem from the viewpoint that control of information is synonymous with control of the political and economic processes, thus leaving many governments unwilling to remove their control in this area. *Id.* Private ownership is often envisioned by governments in developing countries to have two possible outcomes. *Id.* One is that a single company or group may form an economic and information oligarchy which then undermines the powers of the government. *Id.* The second possibility is one in which a robust telecommunications system “would result in a massive decentralization of power by creating a radical democracy and/or a mild form of anarchy where the government is not overthrown, but rather, left behind.” *Id.*

²⁶⁶ In Ethiopia, for example, development of ICT infrastructures was stalled due to a closed market controlled by the government. *E-Commerce and Development Report*, *supra* note 1, at 34. Many telecommunications systems in Africa were run as public utilities, having been subsumed by the state at the end of the colonial era. Keck & Djiofack-Zebaze, *supra* note 258, at 7.

²⁶⁷ Keck & Djiofack-Zebaze, *supra* note 258, at 7. The share of African countries maintaining a state monopoly in the cellular segment from 1995 and 2004 has dropped from 70% to under 10%. *Id.* Liberalization, however, within the fixed-line segment has not occurred as quickly. *Id.*

²⁶⁸ *Id.* However, one should note that within these figures many countries maintained duopolies instead of providing genuine competition. *Id.*

²⁶⁹ *Id.*

tive oversight and enforcement of regulations and improved measures to encourage competition.²⁷⁰

Regional efforts like AfrISPA have paved the way for the future of telecommunications in the region.²⁷¹ Incentives to bolster trade and integrate the region by enhancing telecommunications have led to the formation of a number of pan-African, non-governmental organizations, including the African Telecommunications Union, the Regional African Satellite Communications Organisation, and the African Information Society.²⁷² Another initiative, the East African Digital Transmission Project, is currently working to connect locations in 74 identified tertiary institutions in Eastern Af-

²⁷⁰ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 218. Whether foreign investment is favorable for long-term sustainable economic development is a hotly debated topic. *See* CAPITAL FLOWS AND DEVELOPMENT FINANCING IN AFRICA, *supra* note 6, at 99–126. Overall, many scholars assert that adopting more liberal policies related to foreign direct investment (“FDI”) to increase economic growth and development will create a more favorable climate for foreign investment in developing countries. BERNAL ET AL., *supra* note 105, at 1. *See generally* *Rethinking the Role of Foreign Direct Investment*, *supra* note 198 (discussing the effects of capital flows in Africa, integrating the positive yet still questionable role that FDI has in the region). Regardless, the fact is that large amounts of infrastructure funding in Africa come from FDI, a reflection of the region’s own inadequate resources. Overall average annual flows of FDI in Africa doubled from the 1970s to the 1980s, increasing to \$2.2 billion. *Id.* at 4. During the 1990s, the level of FDI was \$6.2 billion but rose significantly to \$13.8 billion between 2000 and 2003. *Id.* One looming problem, however, is the widespread misconceptions about FDI and assumptions of its success. *See id.* at 10–11 (noting how one of the negative effects of FDI is hindering domestic investment opportunities and indirectly crowding out and adversely effecting “financial markets and exchange rate appreciation.”); *id.* at 87 (stating how development aid “has not always been tailored towards the priorities of recipients and has had a limited effect on growth and poverty.”). In assessing its own policies in former years, the World Bank stated that in developing countries, private investment in infrastructure did not deliver the expected economic gains. WORLD BANK, 2004 ANNUAL REVIEW OF DEVELOPMENT EFFECTIVENESS: THE BANK’S CONTRIBUTION TO POVERTY REDUCTION 29–30 (2005), *available at* [http://lnweb18.worldbank.org/oed/oeddoelib.nsf/24cc3bb1f94ae11c85256808006a0046/efbce22c91b5796685256ff10057bb6c/\\$FILE/2004_ARDE.pdf](http://lnweb18.worldbank.org/oed/oeddoelib.nsf/24cc3bb1f94ae11c85256808006a0046/efbce22c91b5796685256ff10057bb6c/$FILE/2004_ARDE.pdf). Investment was unevenly distributed, especially to the telecommunications sector, “and dropped sharply after the 1997 Asian financial crisis.” *Id.* at 30.

²⁷¹ *See supra* notes 245–52 and accompanying text.

²⁷² U.N. ECON. COMM’N FOR AFRICA, COMM. ON REG’L COOPERATION AND INTEGRATION, TRADE FACILITATION TO PROMOTE INTRA-AFRICAN TRADE (2005) [hereinafter TRADE FACILITATION TO PROMOTE INTRA-AFRICAN TRADE], http://www.uneca.org/crci/trade_facilitation.htm. The African Telecommunications Union was established in 1999 with the aim “to improve service, access, and interconnections between African countries.” *Id.* The Regional African Satellite Communications Organization was created in the early 1990s, with the objective to “to extend affordable telecommunications services to the entire population of Africa, by setting up telecommunications infrastructure based on satellite technology.” *Id.* The African Information Society Initiative was created 1995 with the objective to bridge the digital divide and “to provide a guiding framework for African countries in modernizing and interconnecting their information and communication infrastructure and services.” *Id.*

rica.²⁷³ IntelCom developed from a collaboration among the Economic Community of West African States (“ECOWAS”) countries, and resulted in a network with 32 interstate links between the 16 ECOWAS countries.²⁷⁴ The Pan African Telecommunications Network (“PANAFTTEL”) is another network that aimed to provide the first international connectivity in the region.²⁷⁵ However, while the PANAFTTEL network remains in use, much of it has deteriorated due to negligence, lack of maintenance, and armed conflicts.²⁷⁶

Another pan-African initiative, the New Partnership for African Development (“NEPAD”), aims to create conditions favorable for private sector investment to attract about \$64 billion in investment.²⁷⁷ Specific initiatives to improve the investment climate, corporate governance, and opportunities for SMEs have been launched with this objective in mind.²⁷⁸ NEPAD created the e-Africa Commission in 2001 to supervise and manage projects

²⁷³ STEINER ET AL., *supra* note 4, at 81.

²⁷⁴ *Id.* at 89. The objectives of IntelCom were to improve the telecommunications network within the region. ECOWAS Official Site, Achievements of ECOWAS, <http://www.sec.ecowas.int/sitecedaao/english/achievements-2.htm> (last visited Mar. 27, 2007). The main objectives of the initiative included: opening access to Member States, implementing the missing links in the Western African Pan African Telecommunications Network (“PANAFTTEL”), establish “micro wave links between the capital cities of Member States” and “to increase telecommunications traffic within [the Economic Community of West African States (“ECOWAS”) countries.]” *Id.*

²⁷⁵ TRADE FACILITATION TO PROMOTE INTRA-AFRICAN TRADE, *supra* note 272.

²⁷⁶ STEINER ET AL., *supra* note 4, at 73.

²⁷⁷ Cecile Plaidy et al., *International Legal Developments in Review: 2002 Business Transactions and Disputes*, 37 INT’L LAW 457, 458 (2003). The New Partnership for African Development (“NEPAD”) member states are Rwanda, Congo, Gabon, Cameroon, Kenya, Ethiopia, Mauritius, Egypt, Libya, Algeria, Tunisia, Angola, Mozambique, Botswana, South Africa, Nigeria, Senegal, Mali, and Ghana. NEPAD, Welcome, <http://www.nepad.org> (go to “NEPAD By Country”, then follow “Central Africa” or “East Africa” or “North Africa” or “Southern Africa” or “West Africa” hyperlink). The principles of NEPAD are: good governance as a basic requirement for peace, security and sustainable political and socio-economic development; African ownership and leadership, as well as broad and deep participation by all sectors of society; anchoring the development of Africa on its resources and resourcefulness of its people; partnership between and amongst African peoples; acceleration of regional and continental integration; building the competitiveness of African countries and the continent; forging a new international partnership that changes the unequal relationship between Africa and the developed world; and ensuring that all Partnerships with NEPAD are linked to the Millennium Development Goals and other agreed development goals and targets. NEPAD, NEPAD in Brief, <http://www.nepad.org/2005/files/inbrief.php>.

²⁷⁸ THE NEW PARTNERSHIP FOR AFRICA’S DEV., NEW PARTNERSHIP FOR AFRICA’S DEVELOPMENT (NEPAD) ANNUAL REPORT 2003/2004 40-41 (2004), *available at* <http://www.nepad.org/2005/files/documents/165.pdf>. NEPAD’s primary objectives are to eradicate poverty, set African countries on a path towards economic development and sustainability, integrate Africa within the world economy, and aid in the empowerment of women. *Id.* at 11.

to improve Africa's ICT infrastructure.²⁷⁹ NEPAD's overall goal in regard to ICT infrastructure is "to connect all African countries to a broadband terrestrial fibre-optic network."²⁸⁰ Specific NEPAD objectives for ICTs are to increase teledensity²⁸¹ from 1.6 percent in 2001 to 10 percent by 2007 as well as to harmonize telecommunications regulations and approaches to strengthening telecommunications institutions.²⁸² In addition, NEPAD aims to provide an adequate level of telephone access for households, lower the cost and improve reliability of service, achieve e-readiness for all African nations, develop and produce a pool of ICT-proficient youth, and develop local-content software.²⁸³ To achieve these objectives, recommendations include working with "regional agencies such as African Telecommunications Union and Africa Connection to design model policy and legislation for telecommunications reform."²⁸⁴ Other suggestions include establishing training and research institutions, promoting projects to connect schools and youth centers, and working with financial institutions and international organizations and initiatives to establish financial mechanisms to reduce financial risk.²⁸⁵

Telecommunications reforms over the past five years, including the abolishment of monopolies, privatization of state-owned firms, improved opportunities for competition among new telecommunications operators, and the creation of new regulatory authorities, have effectuated considerable changes in the health and outlook of the sector.²⁸⁶ Despite the fact that regulatory reforms are still in need, steps towards progress have been made to improve the telecommunications sector in sub-Saharan Africa.

V. STATE AND LOCAL INITIATIVES AND WIMAX: FROM SEEKERS TO CREATORS OF CHANGE

A. WiMAX in sub-Saharan Africa

Broadband connectivity is deemed a vital component in accelerating ICT development.²⁸⁷ Broadband offers access to services unavailable over dial-

²⁷⁹ *Id.* at 25.

²⁸⁰ *Id.* at 26.

²⁸¹ *See supra* note 106 and accompanying text for definition on teledensity and specific challenges surrounding it.

²⁸² THE NEW PARTNERSHIP FOR AFRICA'S DEV., INFRASTRUCTURE SHORT-TERM ACTION PLAN (STAP): REVIEW OF IMPLEMENTATION AND THE WAY FORWARD 14 (2004), *available at* <http://www.nepad.org/2005/files/documents/114.pdf>.

²⁸³ THE NEW PARTNERSHIP FOR AFRICA'S DEV., BRIDGING THE INFRASTRUCTURE GAP 2 (2005), *available at* <http://www.nepad.org/2005/files/documents/30.pdf>.

²⁸⁴ *Id.*

²⁸⁵ *Id.* at 2–3.

²⁸⁶ Keck & Djiofack-Zebaze, *supra* note 258, at 5.

²⁸⁷ ICT, E-BUSINESS, AND SMES, *supra* note 158, at 4.

up connections, such as VoIP.²⁸⁸ SMEs, cyber cafes, health facilities, and educational institutions all can benefit from obtaining access to the voice, data, and Internet services available through broadband, in addition to expanding and enhancing existing applications.²⁸⁹ Wireless broadband options are distinctive because they provide “both mobility and portability, efficiently connecting devices within short distances, and bridging longer distances more efficiently than wireline and cable technologies.”²⁹⁰ Wireless technologies do not require “running copper, cable, or fiber lines to individual homes [and businesses],” thus the costs are lower than with other technologies.²⁹¹

Broadband access in Africa, however, is in a “nascent stage” due to limited fixed, landline infrastructure and bandwidth capacities.²⁹² The number of broadband users Africa in 2002 was only in the thousands,²⁹³ comprising only 0.1 percent of the total worldwide fixed as well as wireless broadband subscribers.²⁹⁴ While broadband access has expanded overall, it has done so at various rates throughout the continent.²⁹⁵ WiMAX technology has only recently entered into the market in this region even though BWA, a predecessor of WiMAX, has been used in Africa for voice and data services for more than ten years.²⁹⁶ To obtain wireless broadband access, operators have been using various methods, including WLANs, fixed wireless access, and Very Small Aperture Terminal, all of which are inferior to WiMAX.²⁹⁷

Most African nations will not be fully open to competition in the telecommunications sector until 2010,²⁹⁸ although WiMAX deals have already

²⁸⁸ HIGH-SPEED INTERNET ACCESS—“BROADBAND”, *supra* note 18, at 1.

²⁸⁹ Int'l Telecomm. Union, What Does Broadband Offer for Africa?, <http://www.itu.int/AFRICA2004/media/broadband.html> [hereinafter What Does Broadband Offer for Africa?](last visited Mar. 27, 2007).

²⁹⁰ WIRELESS BROADBAND TASK FORCE REPORT, *supra* note 20, at 140.

²⁹¹ *Id.*

²⁹² What Does Broadband Offer for Africa?, *supra* note 289.

²⁹³ *Id.*

²⁹⁴ Dave Glazier, *Africa Has Less Than 0.1% Broadband Users*, ITWEB, Nov. 7, 2006, <http://www.itweb.co.za/sections/telecoms/2006/0611071033.asp?A=ITG&S=IT%20in%20Government&O=FPIN>.

²⁹⁵ Alastair Otter, *African Broadband Access Accelerates*, TECTONIC, Dec. 9, 2005, <http://www.tectonic.co.za/view.php?src=rss&id=762>.

²⁹⁶ Zvi Slonimsky, CEO, Alvarion, *WiMAX Trends in Africa & the Middle East: Emerging Opportunities for Operators and Providers*, http://www.wirtel.co.uk/article_africa_2005_q3_001_alvarion.htm (last visited Mar. 27, 2007).

²⁹⁷ Very Small Aperture Terminals are “earthbound station[s] used in communications of data, voice, and video signals, excluding broadcast television, consisting of two parts: a transceiver placed outdoors in direct line-of-sight to the satellite, and a device placed indoors to interface the transceiver with the end user’s communications device, such as a PC.” THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES, *supra* note 27, at 123.

²⁹⁸ *WiMAX/BWA in Africa*, *supra* note 257.

been made in a handful of nations. Mauritius deployed the world's first nationwide WiMAX network in 2005.²⁹⁹ Ghana is set to deploy a nationwide mobile WiMAX network, which will give the country its "first 802.16e software upgradeable network," and will offer wireless broadband access to Ghana's population of 22 million people.³⁰⁰ The Democratic Republic of Congo has plans to install a WiMAX-ready network developed by Alvarion, an Israeli corporation.³⁰¹ Alvarion is currently increasing and improving the country's existing wireless broadband network.³⁰² South Africa projects the introduction of WiMAX services to complement its current Asymmetric Digital Subscriber Line³⁰³ services in 2007.³⁰⁴ ZTE, "China's largest listed telecommunications manufacturer and leading wireless solutions provider," will provide Mundostartel, an Angola-based telecommunications company, with WiMAX equipment to build a nationwide WiMAX network in Angola.³⁰⁵ Covering three cities, the Angolan network is expected to provide Internet and VoIP services to at least 6 million people.³⁰⁶

²⁹⁹ *Mauritius World's First Unwired WiMax Nation*, FIERCE WIFI, June 22, 2005, <http://www.fiercewifi.com/story/mauritius-world-s-first-unwired-wimax-nation/2005-06-22>.

³⁰⁰ *Ghana Set for Nationwide Mobile WiMAX Network*, Sept. 4, 2006, <http://www.edn.com/index.asp?layout=article&articleid=CA6368410&partner=news&industryid=21376>.

³⁰¹ Press Release, Alvarion, Microcom, ISP in Democratic Republic of Congo, First to Deploy Alvarion's Wi-MAX-READY Network in Central Africa (Apr. 25, 2005), <http://www.alvarion.com/presscenter/pressreleases/2131/>; Alvarion, Locations, <http://www.alvarion.com/company/locations/> (last visited Mar. 27, 2007). This makes the country the first in central Africa to deploy Alvarion's WiMAX-ready networks. *Id.* Alvarion, headquartered in Tel Aviv, Israel, is the largest pure BWA/WiMAX system vendor in the world and has brought 50 BWA/WiMAX networks to Africa. *WiMAX/BWA in Africa*, *supra* note 257. Countries with Alvarion networks include South Africa, Ivory Coast, Congo, Burkina, Faso, Kenya, Namibia, Nigeria, Botswana, Swaziland, Madagascar, Eritrea, Benin, Tanzania, Uganda, Angola, Zimbabwe, Angola, Ghana, Guinea, Liberia, and Mauritania. *Id.*

³⁰² *Inter-Connect in Congo Improves, Expands Its Broadband Wireless Network with New Alvarion Equipment*, WiMAX INDUSTRY, Mar. 21, 2006, <http://www.wimax-industry.com/ar/5e.htm>. As of September 2006, the Democratic Republic of Congo had 140,600 Internet users, which reflects a 0.2 percent penetration rate of the population. Internet World Stats, <http://www.internetworldstats.com/africa.htm> (last visited Mar. 27, 2007).

³⁰³ Asymmetric Digital Subscriber Line is "used primarily by residential customers, such as Internet surfers, who receive a lot of data but do not send much." HIGH-SPEED INTERNET ACCESS—"BROADBAND," *supra* note 18, at 2.

³⁰⁴ Damaria Senne, *Telkom to Deploy WiMAX Early 2007*, ITWEB, Sept. 6, 2006, <http://www.itweb.co.za/sections/telecoms/2006/0609061038.asp>.

³⁰⁵ *ZTE Deploys in Angola*, UNSTRUNG, Oct. 11, 2005, http://www.unstrung.com/document.asp?doc_id=82178.

³⁰⁶ *Id.*

B. Defying Obstacles, Circumventing Barriers: Envisioning Future Solutions through the Basics

The pending leap to WiMAX may encounter significant challenges: not only must the technology exist, but the regulatory environment must not be hostile. While regulatory reforms have, to some extent, improved the state of telecommunications in sub-Saharan Africa, they have not resolved many issues for most individuals and businesses. External debt, among other factors, has deterred many state resources from being allocated to educational and health institutions as well as towards agricultural development.³⁰⁷ Rather than wait, however, some individuals seeking change have become creators of change. In many ways, ICTs have greatly impacted individuals' abilities to transform, through his or her own initiatives, existing circumstances of necessity into opportunity.³⁰⁸ If prior ingenuity is a predictor of future utilization of wireless technologies, finding ways to deploy WiMAX despite financial or regulatory obstacles seem to be most certain. Through the use of new technologies, many individuals have creatively circumvented arduous barriers and costs to obtain telecommunications connectivity.

1. Cellular Phones: Resourceful and Cost-Effective Wireless Connections

Cellular phones in Africa have been "so successful that in many cases they have replaced fixed lines."³⁰⁹ Africa is currently the world's fastest growing cellular phone market, which in part can be attributed to unreliable or nonexistent landlines.³¹⁰ In 1995, there were less than ten million cellular phone users in Africa.³¹¹ By contrast, thirteen million Africans became new cellular users in 2003 alone.³¹² In the intervening years, many nations opened their cellular telecommunications sector to foreign companies, introducing competition that has "reduced user costs while expanding service to the more remote areas in many African countries" like Ghana

³⁰⁷ CAPITAL FLOWS AND DEVELOPMENT FINANCING IN AFRICA, *supra* note 6, at 44.

³⁰⁸ In discussing the role of knowledge in society in relation to the rational economic order, F.A. Hayek stated that, "If we can agree that the economic problem of society is mainly one of rapid adaptation to changes in the particular circumstances of time and place, it would seem to follow that the ultimate decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them." F. A. Hayek, *The Use of Knowledge in Society*, 35 THE AM. ECON. REV. 519, 524 (1945).

³⁰⁹ *Information Economy Report 2006*, *supra* note 13, at 5.

³¹⁰ *BBC WAP Flourishing in Africa*, BBC NEWS, Aug. 15, 2006, <http://news.bbc.co.uk/2/hi/africa/4795255.stm>. In terms of the number of users, the cellular phone is the only ICT in which developing countries have surpassed developed countries. *Information Economy Report 2006*, *supra* note 13, at 3.

³¹¹ Keck & Djiofack-Zebaze, *supra* note 258, at 5.

³¹² *Id.*

and Tanzania.³¹³ Mobile phone penetration in Africa in 2003, however, was still only about 6 percent while global penetration was 22 percent.³¹⁴

“Whereas many Africans [could not] take on the cost of a monthly fee for a fixed-line rental, the option of a prepaid telephone calling cards opened new doors.”³¹⁵ Cellular base stations offer low costs as well as longer ranges, enabling services to be provided to many rural areas that previously did not have any telecommunications access.³¹⁶ Families, even entire communities, invest their money into a single, shared cellular phone and pool money for calling cards and service.³¹⁷ Even if there is no money to make outbound calls, inbound calls can still be received without additional costs.³¹⁸ Other cost-saving practices have also developed such as placing a call to a cellular phone but hanging up before the call is answered. This practice is a widely used and allows someone to see that someone is trying to reach them without spending the money to connect the call.³¹⁹

Cellular phones also have economic relevance because they are “enablers” of business, especially for entrepreneurs.³²⁰ Many obstacles, like overregulation, have hindered individuals and SMEs from taking advantage of local economic opportunities. Overall, Africa’s business start-up procedures remain the most difficult to navigate of any region in the developing world:³²¹ seven of the world’s ten most difficult nations in which to register a business due to bureaucratic or expensive procedures are in Africa.³²² In most African nations, “registration and licensing are serious obstacles to formalizing a business,” and registering a company can easily become a complex, lengthy, arduous, and expensive task due to overregulation.³²³ Not only are registration costs high, but companies often become overwhelmed by the number of documents and forms that must be filed

³¹³ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 31.

³¹⁴ Keck & Djiofack-Zebaze, *supra* note 258, at 5.

³¹⁵ Lisa Waldick, *The Best Policy: Telecom Research from an African Perspective*, THE INT’L DEV. RES. CENTER REP., Nov. 17, 2003, http://www.idrc.ca/en/ev-46209-201-1-DO_TOPIC.html.

³¹⁶ African Internet Infrastructure Information – A Status Report, *supra* note 201.

³¹⁷ Waldick, *supra* note 315.

³¹⁸ *Id.*

³¹⁹ See Donner, *supra* note 185, at 2–3.

³²⁰ *Information Economy Report 2006*, *supra* note 13, at 3.

³²¹ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 255. Some countries in Northern Africa, such as Morocco or Tunisia, have registration procedures which are far superior to some Latin American or Asian countries, but they are in the minority. *Id.*

³²² *Id.* “[A]ngola, Chad, the Democratic Republic of Congo, Togo, and Guinea [are] the most difficult [countries] for formalizing a business.” *Id.*

³²³ *Id.*

and registered.³²⁴ In terms of ICT development, individuals and companies face long bureaucratic procedures and must pay numerous fees to telecommunications sectors in emerging economies to obtain licenses for equipment or spectrum use.³²⁵ Some nations, for example, “charge license fees for hotspot equipment or sites and one-time or annual license fees for access-point devices.”³²⁶ Additionally, state corruption and bribery commonly preside along with arbitrary interpretations of rules and regulations by government officials.³²⁷ Overregulation hinders local and domestic growth in Africa by constraining local businesses from launching or effectively managing their existing businesses.³²⁸ Cellular phones, however, have enabled individuals to provide informal on-the-ground services, evading the need to proceed through formal procedures and the setbacks of overregulation.

In effect, a single technology, the cellular phone, has transformed scant opportunities into benefits and earnings. Companies, local vendors, and individuals have invested in cellular phones to provide cellular public payphones in response to a lack of fixed public payphones.³²⁹ Furthermore, “tradesmen, such as bricklayers and painters advertise themselves by giving a mobile phone number, taxi drivers are contacted by phone, and retailers avoid unnecessary travel by pre-shopping over the phone for supplies.”³³⁰ What the cellular phone has provided, more noteworthy than mobility, is accessibility to communications. “It is significant that many of the businesses had no form of telephone access before the acquisition of a mobile phone.”³³¹

³²⁴ *Id.*

³²⁵ Alex Leblais, *A Global Standard Meets Local Policies and Politics*, in *THE WIRELESS OPPORTUNITY FOR DEVELOPING COUNTRIES 17* (Wireless Internet Institute ed., 2003), available at <http://www.infodev.org/en/Publication.24.html> (follow “Download Now” hyperlink).

³²⁶ *Id.*

³²⁷ *MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA*, *supra* note 3, at 259. Along with its many procedural problems, overregulation is associated with the unpredictable interpretation of regulations which may lead to corruption. “Corruption is generally connected with the activities of the state and especially with the monopoly and discretionary power of the state.” *Id.*

³²⁸ *Id.* at 253. Overregulation also discourages all private sector activity and investment, both locally and from abroad. Maintaining the status quo on regulations has frustrated numerous attempts by the private sector from capitalizing on and harnessing potential opportunities for economic and financial growth. *See id.*

³²⁹ *See* Waldick, *supra* note 315. Louis Anselme Kasamba, an 18-year-old Congolese determined to save money for college, rode his bike 100 miles to purchase a cell phone for \$63. He now sells use of the phone at an average of \$.50 a minute and has \$100 saved towards his college fund. Beth Duff-Brown, *They Are So Rich, and They are So Poor: After Long Turmoil, Signs of Progress Appear in Congo*, WASH. POST, Oct. 22, 2006, at A20.

³³⁰ *Information Economy Report 2005*, *supra* note 125, at 15.

³³¹ *Id.*

Specific projects have also allowed individuals to expand the use of cellular phones into an economic opportunity. Village Phone is a program which provides financing so that an individual can establish a Village Phone business in his or her rural community.³³² The individual business owner rents the use of the phone to other villagers on a per-call basis.³³³ Access to affordable telecommunications is gained by the community while allowing the individual to earn enough to repay the loan and raise his or her level of income.³³⁴ The Village Phone program currently operates in villages in Nigeria, Rwanda, and Uganda.³³⁵

Cellular phones also offer new opportunities for the dissemination and sharing of vital information. Some African health clinics and medical institutions provide cellular phone-based health information systems.³³⁶ Similarly, companies like Manobi, a Senegalese service that tracks agriculture prices, provides agricultural prices over cellular phones and is routinely accessed by more than 3,500 producers.³³⁷ News summaries and basic information can be obtained on cellular phones through wireless application protocol (“WAP”) services.³³⁸ The British Broadcasting Corporation (“BBC”) noted a 100 percent WAP usage increase between 2005 and 2006,

³³² Grameen Foundation, Frequently Asked Questions about Village Phone Direct, http://www.grameenfoundation.org/what_we_do/technology_programs/village_phone_direct/faq_village_phone_direct/ (last visited Mar. 27, 2007). The objective is to connect the telecommunications sector with the microfinance sector. *Id.* Another program, Village Phone *Direct*, provides further options by allowing a client “to bring mobile communication services and new business opportunities to their clients and select the local telecommunications provider.” *Id.* The client receives a Village Phone *Direct* kit which includes: “Nokia mobile phone with earpiece, external booster antenna for areas without strong mobile signal coverage, and custom designed cables to connect the phone to the antenna and the recharging equipment such as an automobile battery or a solar panel.” *Id.* In addition, “a SIM card and prepaid airtime will also be needed and can be purchased through regular outlets. *Id.* Additional items such as signage and marketing material may be produced by the microfinance institution.” *Id.*

³³³ *Id.*

³³⁴ *Id.* Grameen Foundation has programs in India, Pakistan, Bangladesh, Indonesia, China, East Timor, The Philippines, El Salvador, Honduras, Mexico, Bolivia, The Dominican Republic, Haiti, Morocco, Tunisia, Egypt, and Saudi Arabia. Grameen Foundation, Where We Work, http://www.grameenfoundation.org/where_we_work/ (last visited Mar. 27, 2007).

³³⁵ Grameen Foundation, What We Do, http://www.grameenfoundation.org/what_we_do/technology_programs/village_phone/ (last visited Mar. 27, 2007).

³³⁶ Donner, *supra* note 185, at 4–5. *See also* discussion *supra* notes 180–82 and accompanying text for a discussion of the use of cellular technology to combat HIV/AIDS in Rwanda.

³³⁷ *See* Manobi, <http://www.manobi.net/worldwide/> (last visited Mar. 27, 2007).

³³⁸ *See* BBC WAP *Flourishing in Africa*, *supra* note 310.

with 61 percent of BBC's international WAP users coming from Nigeria and 19 percent coming from South Africa.³³⁹

Cellular phones "can amplify access to telecommunication,"³⁴⁰ and moreover, their usage can, and has, transformed and adapted into financial opportunities. The ways in which they have been creatively used to meet the demands and needs of individuals and local communities foretells that future technologies, such as WiMAX, will also accordingly be adapted despite the obstacles.

2. Consolidating Efforts, Increasing Effectiveness

Sub-Saharan education and agriculture sectors have consolidated efforts and resources domestically and internationally to create broader bases of knowledge and information. ICTs have greatly facilitated research, knowledge, data transfer, and the ability to quickly communicate.³⁴¹ The need for teachers and education specialists in some areas has been met by combining resources through telecommunications.³⁴² Five training centers in Zimbabwe provide online training for teachers.³⁴³ Efforts have been made to connect teachers online in Kenya, Uganda, and Zimbabwe.³⁴⁴ In addition, the Kenya Education Network was established in 1999 to foster "sustainable communication and networking among educational institutions in Kenya."³⁴⁵ In Nigeria, the Nigerian Universities Network was established in 1995 to purchase satellite bandwidth to improve the quality of service of bandwidth received by its member institutions.³⁴⁶ The African Virtual University ("AVU") is an example of a consortium arrangement that is composed of 38 African educational institutions.³⁴⁷ The AVU aims to bring content from around the world, and thus students in Africa can access educational materials through other consortium universities, which include American universities like the Massachusetts Institute of Technology and

³³⁹ *Id.* News obtained from BBC through cellular phones occurs more frequently than news obtained through the Internet due to slow and unreliable landlines. *Id.* The BBC stated that it receives regular messages of thanks from people in Africa, who say the only access they have to news is via their mobiles. *Id.* One individual in Uganda sent a text message thanking BBC, saying that "the only access I have 2 the outside world is this pinhole 2 info cause I don't have access to TV." *Id.*

³⁴⁰ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 253.

³⁴¹ See discussion *supra* Part III.B.ii.

³⁴² *Id.* at 189.

³⁴³ *Id.*

³⁴⁴ *Id.* at 191.

³⁴⁵ STEINER ET AL., *supra* note 4, at 13.

³⁴⁶ *Id.* at 18.

³⁴⁷ *Id.* at 23. Countries within the AVU include Somalia, Ethiopia, Kenya, Uganda, Rwanda, Burundi, Malawi, Tanzania, Mozambique, Zimbabwe, Namibia, Mauritania, Mali, Niger, Nigeria, Ghana, Senegal, Gambia, and Burkina Faso. *Id.* at 22.

the New Jersey Institute of Technology.³⁴⁸ The AVU also aims to address connectivity issues by reducing costs to access the Internet and by improving the quality of service of the connections.³⁴⁹ The network provides videoconferencing, training, technical support, and general Internet services.³⁵⁰ By pooling resources, educational institutions throughout Africa have made significant progress in bringing ICT access to their students and employees.

Agriculture plays a prominent role within the region and is regarded both as the barrier and key for sustainable growth as a means to reduce poverty.³⁵¹ Low production in the agricultural sector is strongly linked to the region's poverty problems.³⁵² The agricultural industry is the largest employer in the region.³⁵³ Two-thirds of the population lives in rural areas,³⁵⁴ and 90 percent of the rural population is employed in the agricultural sector.³⁵⁵ The sector's low productivity growth, however, has made employment and income security unpredictable.³⁵⁶

Initiatives like the Comprehensive African Agricultural Development Program are attempting to revitalize and modernize agricultural development and productivity.³⁵⁷ ICTs have had a role concurrent to such initiatives in allowing individuals and SMEs to share information to build a knowledge-based network for the agricultural sector. The Kenyan Agricultural Commodity Exchange ("KACE"), for example, was launched in 1997 to disseminate marketing data and information to sellers and buyers of agricultural goods.³⁵⁸ The KACE network utilizes various forms of ICTs, which include "market information points, market information centres, short messaging services, interactive voice response service, regional

³⁴⁸ *Id.* at 22–23.

³⁴⁹ *Id.* at 23

³⁵⁰ *Id.*

³⁵¹ See WORLD EMPLOYMENT REPORT, *supra* note 8, at 127–82 (discussing the relevance of agriculture in Africa in terms of development, employment, and production). The region has an abundance of land, nearly 8 times more than in India "with two-thirds the number of people to feed . . . [which] implies that yield-enhancing productivity gains will have equitable growth consequences, and that growth in agriculture will likely reach those who need it most." *Id.* at 154.

³⁵² *Id.* The agricultural sector has not provided opportunities for sustained or long-term employment, and as result, many individuals have intermittent or sporadic periods of employment. See MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 1.

³⁵³ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 1.

³⁵⁴ WORLD EMPLOYMENT REPORT, *supra* note 8, at 154.

³⁵⁵ MEETING THE CHALLENGES OF UNEMPLOYMENT AND POVERTY IN AFRICA, *supra* note 3, at 129.

³⁵⁶ *Id.* at 1.

³⁵⁷ *Id.* at 142.

³⁵⁸ *Id.* at 155.

commodity trading, and information systems and a website.”³⁵⁹ Clients range from large farm operators to farmers to commodities dealers, importers and exporters.³⁶⁰

Successful utilization of the Internet, cellular phones, and other ICTs has enhanced the transfer of data and information to benefit the local community. Seizing upon such opportunities is significant not only because it accelerates and improves both current and future prospects, but also because, in the face of limited resources, individuals, clinics, businesses, and organizations have turned necessity into opportunity and pooled local resources to create solutions.

C. Prospects for the Future and Paving the Way

Until fully operable wireless networks like WiMAX networks come to fruition, an amalgamation of technologies will most likely flourish, combining WiMAX, Wi-Fi and 3G technologies to provide broad coverage and access to new users. Wi-Fi spots can serve areas up to several miles, with WiMAX extending that service up to 30 miles away, although much would depend on the conditions of the terrain between access points.³⁶¹ For areas where cellular networks already exist, 3G high-speed mobile networks provide another option to bridge the access points.³⁶² Combining WiMAX with other technologies and applications such as private mobile radio (“PMR”) could provide access to customers where cellular usage is too costly or nonexistent.³⁶³ Broadband Internet can be delivered to rural areas by connecting WiMAX with national railways which utilize PMR networks and have IP-addressable base stations.³⁶⁴

Although technologies like WiMAX are new, use of the spectrum bands are not. Most countries in the region use either the 2.4 or 5 GHz bands or both to varying degrees.³⁶⁵ “The ubiquitous use of the 2.4 and 5GHz bands” indicates an opening exists for WiMAX in the region.³⁶⁶ However, disparate regulations throughout the region could inhibit the impact of WiMAX deployment and discourage participation.³⁶⁷ Regulatory measures must be implemented to ensure that a “no-interference working plan and a

³⁵⁹ *Id.*

³⁶⁰ *Id.*

³⁶¹ Islam, *supra* note 101.

³⁶² *Id.*

³⁶³ Mike Norfield, *A Call For a New Wave of PMR*, TOTAL TELECOM, Nov. 13, 2006, <http://www.totaltele.com/View.aspx?t=4&ID=87656>. Cellular is not cost effective for areas that are remote. *Id.*

³⁶⁴ *Id.*

³⁶⁵ Neto et al., *License-Exempt Wireless Policy: Results of an African Survey*, 2 INFO. TECHNOLOGIES & INT’L DEV. 73, 83–84 (2005).

³⁶⁶ *Id.* at 84.

³⁶⁷ *See id.* at 76–83.

‘good neighbor’ attitude” are maintained.³⁶⁸ One important step towards establishing a wireless network utilizing WiMAX will be developing a spectrum policy allocating bands, such as the 2.4 GHz and 5 GHz, for unlicensed applications.³⁶⁹

For all the excitement and interest, the full extent of WiMAX’s success and wireless technologies in the region remains to be determined. The ability of individuals to turn necessity and lack of financing into innovative solutions may in fact surpass government initiatives and policies in determining the future for wireless technologies such as WiMAX. WiMAX may not provide immediate relief to the region’s entrenched problems; however, deployment of WiMAX networks in developing nations has the potential to resolve larger economic and social problems and provide better options for the future of Africa.

VI. CONCLUSION

It could be a decade before wireless networks achieve a dominant position in many developing nations. Effective and sustained results, however, must not be compromised for immediate rewards.³⁷⁰ Neither WiMAX nor any other wireless technology or ICT can succeed entirely on its own without the proper regulatory environment or network infrastructure. To extend the reach of the positive effects of ICTs on the economic growth of developing nations “an enabling environment for ICTs needs to be created at the national and international levels.”³⁷¹ The challenge of introducing the information and knowledge obtained from ICTs “in a fashion that allows the local population to adopt and utilize it” will remain.³⁷²

WiMAX is only the beginning in overcoming the obstacles that have beset the region for decades and toward expanding access to wireless broadband in order to reap its notable benefits. For many African nations that have been struggling with dial-up or limited broadband access, the hope for WiMAX is caught up amidst anticipated disappointment from past experience. To compare the expansive growth mobile phones and carriers have

³⁶⁸ Kahn, *supra* note 11, at 18. Current inconsistent conditions and restrictions could deter further development. In Eritrea, for example, a monopoly operator may use the 2.4 GHz and 5 GHz bands without restrictions as opposed to companies like ISPs who must pay fees. Neto et al., *supra* note 365, at 82. In Namibia, although bands are unlicensed, use of the band beyond one’s property is illegal. *Id.* In South Africa, unlicensed bands are allowed only for use in confined areas, such as indoor locations. *Id.*

³⁶⁹ See Neto et al., *supra* note 365, at 77.

³⁷⁰ The challenge for many developing countries has been to liberalize trade and adopt more liberal policies that may be to their own disadvantage. Improving investment policies necessitates the country to evaluate and assess how its policies shape the reactions and incentives of facing firms within that country. See BERNAL ET AL., *supra* note 105, at 4.

³⁷¹ *E-Commerce and Development Report*, *supra* note 1, at 19.

³⁷² Cukor & McKnight, *supra* note 13, at 53.

had in Africa to WiMAX is somewhat preliminary. However, like cellular phones, WiMAX may provide a more expansive alternative to the problems associated with fixed lines. Even if WiMAX were to gain ground and provide more cost-beneficial, efficient, and faster solutions, WiMAX is only one small element of a larger framework needed to develop a successful, comprehensive telecommunications network. ICTs cannot be fully effective without the proper regulatory scheme, investment, and skilled labor necessary to sustain them. However, WiMAX presents the potential for leapfrogging barriers in the short-term, and the means to initiate and provoke systemic changes for long-term development in many African nations.