

THE **DRA** Accelerating Disparity
Reducing Advances
PROJECT



Cell Phones and Reducing Health Disparities

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Cell Phones and Reducing Health Disparities

Introduction	3
Need	4
Opportunities	4
Recommendations	5
Background Paper	6

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Cell Phones and Reducing Health Disparities

INTRODUCTION

Cell phones were chosen at the April 2006 DRA Project Partners meeting as an important area to explore for potential disparity reducing advances. Cell phones, in this context, include hand sets, the infrastructure they work on, and the services that they provide. Increasingly, cell phones will be used in a wide range of health applications. Cell phones can be biomonitors, recording information or conveying biomonitoring data from an individual to data storehouses or to their health care provider. Other DRA Project exploratory reports, particularly *Continuous, Passive Biomonitoring for Health and Prevention* and *Community & National Biomonitoring to Support Upstream Change*, consider gathering health information from individuals, some of which may be transmitted via a cell phone. Thus, some of the considerations and recommendations in this report will parallel those.

A background report, included below, provides more details on the range of developments on which we based this review of opportunities and recommendations.

Cell phone health applications are already available for recording and reinforcing nutrition, testing glucose, and managing diabetes. In addition, cell phones will become integral tools in delivering audio, text, and video messages including games that reinforce healthy behavior.

Additionally, cell phones are becoming important internet devices. Some forecasts suggest that soon many people will use internet access to provide their telephone services, and there are proposals to provide free or low cost community internet access. Many cities have already begun to provide free internet access over Wi-Fi, while more powerful WiMax technologies will expand this capacity. There are other approaches to low cost or free internet access being proposed.

It is important to note that the digital divide is lower in cell phones than other areas of technology.

The value to health is that cell phone related applications could:

- Provide early warning of disease
- Provide real time monitoring of conditions, reinforcing effective treatment, and
- Reinforce healthier behavior in culturally appropriate ways.

This is a preliminary exploration. We'd like to thank several experts in this field who provided us input for this report: Jay Sanders, American Telemedicine Association; John Horrigan, Pew Project on the Internet and American Life; Gerard Kleisterlee, Royal Philips Electronics, Inc.; Andrew Kreig, Wireless Communication Association International; Kevin Werbach, Wharton School of the University of Pennsylvania; Karen Reddering, Philips Design; and Robin Felder, Medical Automation Research Center of the University of Virginia.

NEED

For cell phones to play a role in reducing rather than increasing disparities there is a need to monitor and forecast developments in this area to understand the possibilities and where a disparity reducing perspective can be introduced. This preliminary review has identified a wide range of developments and opportunities. However, this is only a very preliminary survey.

The details of the current situation include:

- Cell phone use is exploding, including use by lower income households
- Use of cell phones for health applications is just beginning to grow and will likely become significant.
- The infrastructure is uncertain. Telephone services are increasingly including internet access. Wireless services are likely to include phone services. Free or low cost wireless is growing. There are proposals that would lead to free or low cost internet for all. These may or may not be better for disparity reductions than the evolution of the market (in this case auctioning off spectrum to the highest bidders).

OPPORTUNITIES

Potential opportunities include support of cell phone development that contributes to reducing health disparities:

- Identify critical junctures for supporting disparity reduction in equipment or system design, infrastructure and services package development, for self care and managing diseases, particularly for high disparity diseases.
- Increase awareness across stakeholders of the disparity reducing opportunities of cell phone and internet access evolution.
- Get funders and health care providers to provide input on the requirements for effective use and for reimbursement of cell phone related health services.
- Anticipate side effects - As the internet becomes a more powerful platform, including free or low cost access, it is plausible that advertising driven applications will grow in importance. Consideration should be given to the health detracting effects of these advertising trends – as food, tobacco and other advertising currently challenge health.
- Work with guideline, standard setting, and interoperability groups to consider the disparity reducing implications of these systems as they develop.
- Encourage tests/applications using cell phones and related technologies for various health applications among poor and underserved populations.
- Looking forward, the DRA Project can (similar to the recommendations of the continuous passive biomonitoring committee) work with associations such as the Continua Health Alliance to consider the disparity reducing implications of the interoperable standards.
- Encourage “bottom of the pyramid” business strategies for cell phone hand sets, infrastructure, and services.
- Encourage free or low cost municipal and other access
 - Work to ensure that these systems do not leave the poor in a technological backwater, experiencing disparities because of outdated services or infrastructure after a few years.

RECOMMENDATIONS

There are many potential opportunities here. Cell phones and what they evolve into will be significant for communication as well as health. Yet, because of the preliminary stage of this exploration, our primary recommendation is that:

- The DRA Project convene a small meeting to develop a range of scenarios and an agenda of key disparity reducing opportunities.
 - Anticipate juncture points or key decisions that will effect the emergence of biomonitoring and health record developments; provide these to DRA Project groups and to others developing or testing biomonitoring efforts.
- Given the agenda developed by this session, other potential recommendations include
 - Recruit active players (phone, equipment, wireless companies, regulators, consumer/patient groups, and health care providers) to the DRA Project discussion on this.
 - Monitor progress on key lines of development related to the cell phone disparities agenda.
 - Consider some of the opportunities listed above to pursue.

Cell Phones as a Disparity Reducing Advance

**Background Paper
The DRA Project
September 10, 2006**

By Clem Bezold, Takuya Murata, Chris Rosenkrans, and Lex Kiefhaber

Introduction

Cell phones were chosen at the April 2006 DRA Project Partners meeting as an important area to explore for potential disparity reducing advances. Cell phones, in this context, include hand sets, the infrastructure they work on, and the services that they provide. Increasingly, cell phones will be used in a wide range of health applications. Cell phones can be biomonitors, recording information or conveying biomonitoring data from an individual to data storehouses or to their health care provider.

Applications are already available for recording and reinforcing nutrition, testing glucose, and managing diabetes. In addition, cell phones will become integral tools in delivering audio, text and video messages reinforcing healthy behavior. Cell phones are also becoming important internet devices. Some forecasts suggest that many people will soon use internet access to provide telephone services, and there are already proposals to provide free or low cost community internet access.

Today's major health challenges in the U.S. are chronic diseases with great racial and socioeconomic disparities in chronic diseases such as heart disease, cancer, diabetes, and asthma. Given the importance of lifestyle in chronic disease, the focus of health care providers and patients on lifestyle is increasingly important – the patient is becoming an active partner

For example HealthPia in September of 2006 is marketing in the US a diabetes phone.¹ This otherwise normal looking cell phone will include a device for analyzing a finger prick blood test strip and sending the results on to a data center. It will support the patient in managing meal plans by calculating calories taken in. A counselor or health care provider will be able to counsel patients. Various diabetes related information will be made available on the phone.

Cell phone and associated technology seems to be a strong candidate to increase this patient-provider interaction. Cell phones are designed to be small and easily portable and the trend in cell phone development points to further miniaturization and multi-functionality. In addition, cell phones are used widely in historically underserved groups. Cell phones have reached a point in technology diffusion where African and Hispanic groups have become the largest per capita users of basic cell phone usage². The drive for low-cost handsets as well as the growth of cheap or free wireless services in public places points towards less disparity in the next generation of powerful cell phones.

John Horrigan, of the PEW Internet and American Life Project, noted in a DRA Project interview that cell phones will be at saturation point in 5 years. At that time, there will still be some people who don't have cell phones. Just as at present 8% of people do not have phones. The most common reason for not having a phone is high and unpaid long distance bills, rather than monthly cost. Also, of those without telephones in the home, 40% have cable TV. And generally low income users of cable TV are more likely to have premium channels.

Cell phones and biomonitoring, by themselves, will not reduce health disparities. But, if they help to provide better management of disease by patients and their doctors, and if they reinforce healthy behavior, their impact could be significant. Thus, small, cheap, and multifunctional cell phones could be a major disparity reducing advance.

Mr. Horrigan has pointed out that cell phones that provide internet access will be important for low income and minority populations for the biomonitoring described here, but also for health information seeking, and for building community. He notes the emergence of thebeehive.org which provides content to close the literacy gap for low income populations. One-economy.com started thebeehive.org and is supplying broad band connections to low income and affordable housing projects.

The remainder of this paper will explore recent developments and forecasts on cell phone technologies related to health and chronic disease. It is hoped that this material will offer the cell phone committee a starting point.

Cell phone usage explodes

In 1994, only 16 million Americans had subscribed to cellular phone services. This grew to more than 110 million Americans subscribers in 2001³. In 2006, about 2 billion people use cell phones worldwide, and there are more than 203 million subscribers in the US⁴. With a current US population close to 300 million⁵, the cell phone market is still far from saturation. Nine out of ten college students now carry cell phones, and some colleges are considering supporting a shift from fixed to mobile phones⁶. The trend points to even greater use of cell phones. Indeed, by some estimates, “cell phones are expected to become the most common consumer electronics device by 2009, when 1 billion will be sold annually (across the globe).”⁷

Cell Phone as Disparity Reducing Advance

New technologies have a typical diffusion curve. Typically, the wealthy gain access to technologies first, and, after some time, mass production lowers production cost, giving mainstream society greater access. For underserved groups, usually there is significant delay before gaining access. Sometimes it never happens. The question is: Is cell phone use subject to the same diffusion curve, or will the cell phone’s ubiquity and cheapness (especially compared to PCs) lead to a more equalizing diffusion curve? The answer seems to be that cell phones are being taken up strongly, across economic groups.

Cell Phone Usage in 2005 higher among African Americans and Hispanics

According to Telephia, a leading provider of performance measurement information to the mobile industry, the underserved communities in the U.S. were the largest users of cell phone voice minutes per person. African-Americans used the highest number per person and showed 10% growth while Hispanic mobile consumers came in second with an even stronger Q1 to Q3 growth rate. See the chart on the next page for more details.

Total Voice Minutes Used per subscriber (2005)⁸

	Q1	Q2	Q3	Percent Growth Q1-Q3 2005 (%)
Black/African American	1,105	1,190	1,220	10%
Hispanic Origin	868	924	979	13%
Mixed Racial Background	819	818	888	8%
Asian or Pacific Islander	794	779	845	6%
White/Caucasian	580	617	632	9%
Native American/Alaskan Native	595	600	623	5%

Internet penetration rate growing fastest in African Americans and in low education groups

Internet adoption has been accelerating, with the fastest growth among African Americans, and in low education background groups. “Growth in broadband adoption has been very strong in middle-income households, and particularly fast for African Americans and those with low levels of education. Broadband adoption among African Americans increased by 121% between 2005 and 2006.”⁹

Cell Phones are the Next Target for Internet Companies

“Because people spend so much time on their mobile phones, Internet companies are jumping on the opportunity by introducing more Web-browsing features to cell-phone users.”¹⁰ On the cell phone side, Mozilla and AOL are working hard to introduce usable cell phone browsers. Search companies like Google, Yahoo, and MSN are also competing to grab the cell phone-internet market. This market competition is one indication of a strong trend towards cell phone-based internet. Microsoft also says it will put the poor online via cell phone¹¹.

Miniaturization may make cell phone bio-monitoring easier

Miniaturization implies complex bio-monitoring will be easier. For instance, researchers at the California Institute of Technology are building a hand-held lab-on-a-chip to simplify blood tests. A cell phone-sized blood-count machine will require less blood than a mosquito bite, "Only a drop of blood is needed on the tip of the chip". Designed for astronauts to use in space, it is made so that astronauts can do the test themselves, without trained technicians¹². Note the HealthPia diabetes cell phone includes the test equipment for testing glucose level from the finger prick test strip. The hand-held lab-on-a-chip would test much more than glucose levels.

Distant Monitoring Through Small Devices

A variety of monitoring approaches are emerging. In the areas of maternal and fetal monitoring, the Centricity AirStrip OB, from MP4 Solutions, provides real-time remote access to maternal and fetal wave forms coming from Hospital Labor and Delivery units via Windows Mobile Phone Edition PDA's. This works anywhere that there is a cell connection. It also provides access to other real-time, critical medical data coming from Labor and Delivery units. The makers argue that it could significantly reduce both hospital and physician risk in the field of Obstetrics.

Miniaturization of Cell Phones to Accelerate

The miniaturization trend in consumer electronics – especially cell phone design – shows no signs of slowing down. In fact, it’s likely to gain momentum. “There’s more money to be made selling complicated cell phones that squeeze a lot into a little space,” says Minneapolis Star Tribune technology editor, Steve Alexander¹³.

MyHeart Project in Europe Uses Intelligent Biomedical Clothes

In the European Union, several countries, and companies, are pursuing the MyHeart project to develop a combination of functional clothes and integrated electronics and process them on-body, an innovation labelled “intelligent biomedical clothes”. The processing capabilities will include making diagnoses as well as detecting trends. The MyHeart system combines these intelligent biomedical clothes with feedback devices, able to interact with the user as well as with professional services. The system will support improved physical activity, nutrition and dieting, sleep and relaxation, stress management, and early diagnosis and prediction of acute events.¹⁴

Further information on the MyHeart system is available at:<http://www.hitech-projects.com/euprojects/myheart/>

Sleep Monitoring System

(NAPS: Non-Invasive Analysis of Physiological Signals)

The Medical Automation Research Center (MARC) at the University of Virginia, is developing a low-cost, low-power, physiological sensor-suite that can passively acquire important physiological and environmental characteristics and wirelessly communicate the results to the patient’s information systems or to their physician’s system.¹⁵

The NAPS system (Non-Invasive Analysis of Physiological Signals) is a low-cost, low-power, physiological sensor-suite that can passively acquire important physiological and environmental characteristics. The MARC research team has completed preliminary proof-of-concept of the NAPS system, with added value in its ability to be deployed to collect data remotely. The NAPS suite will allow subjects to simply lie on a mattress pad, embedded with sensors, to obtain multidimensional data. The data collection sets can be selected to include: body temperature, heart rate, respiration rate, positional mapping and movement; additional development work is being done to monitor airflow. Furthermore, the system can also measure environmental conditions in the immediate surroundings including ambient light level, humidity, and temperature. Once validated, the NAPS system can be used as an effective screening tool for sleep quality assessment, identifying sleep disorders that require a detailed, clinically administered sleep study, as well as an aid to clinicians in the in-home longitudinal assessment of prescribed treatments to relieve sleep problems. Furthermore, the NAPS system’s ability to accurately monitor these important physiological characteristics and sleep longitudinally will provide an individual baseline that can be utilized for assessment purposes, such as detection of trends and changes.

Possible Major Actors:

While no single actor is pushing the combination of health and cell phones for disparity reduction, there are several major actors that are working in a related space. This section discusses initiatives at Philips, Microsoft, and UC Berkeley.

Low Cost Cell Phones:

Philips to produce \$15 handsets by 2008.

Philips has established a ULC (ultra low cost) Design Center in Shanghai. This ULC Design Center is intended to drive Philips's ultra-low cost activities in China. The center works with Philips's existing European design facilities, and the Bangalore-based Innovation Campus, to reduce costs and ultimately produce handsets to be sold at less than \$20. This initiative is a response to growing consumer spending in rural China, and it plans to offer affordable access to mobile telephony in order to bridge the digital divide.

The decision is part of an overall initiative to address the growing consumer demand for low-cost mobile communications in China, India, Africa, South America and Eastern Europe by driving total handset costs below \$15 by 2008.¹⁶ While these low-cost products currently target emerging markets, it is likely that in the near future other similar low cost products will be introduced in the United States. (Currently many handsets are free with a one or two year subscription).

Below are comments from Philip's on its ultra low-cost handsets:

"The first commercially available ultra low-cost handsets based on the Nexperia™ Cellular System Solution will offer voice, SMS and basic multimedia capability, with a black and white screen, providing the basic functionality and low cost desired by new subscribers in emerging mobile phone markets.

As there are no subsidized mobile phones in China, handset manufacturers must provide consumers with mobile phones they can actually afford. By bringing to market a sub-\$5 Nexperia Cellular System Solution, Philips is enabling its customers to dramatically reduce costs and bring sub-\$20 handsets to the consumer," stated Tony Lear, Senior Vice President and General Manager, Philips Semiconductors China.¹⁷

Philips has also made a major transition from mass manufacturing of electronics to life-style and health. Philip's vision reads, "...we will be a leading solutions provider in the areas of healthcare, lifestyle and enabling technology"¹⁸. Health and health care is large market, with major demand growth worldwide most notably in the US, Europe, Japan, and China. Philips is leveraging its strength in its traditional industry, electronics manufacturing, and is now a major player in medical systems such as patient monitoring.

A relevant press release:

While healthcare may not come top of mind when most consumers think of Philips, our medical business actually generates more than 50 percent of our

revenue in the U.S. We are indeed among the top three players in the global medical equipment market, where we have a market leading position for patient monitoring and a number two position for diagnostic imaging. Philips Medical Systems (PMS) is currently our second largest business, contributing roughly EUR 6 billion to the Group's turnover and is highly profitable.¹⁹

Philips is also a major manufacturer of cell phones. The company is one potential and natural developer of low cost or free cell phone based health monitoring that could reduce health disparities. The excerpt above demonstrates that directors at Philips believe that health is profitable, and Philips has the capability in electronics research and development.

Microsoft to connect the poor to the internet using cell phones

As cheaper cell phones are developed, penetration rates will increase. Bill Gates, through his Gates Foundation, has brought substantial funding to cell phone based internet access, accelerating this trend. Gates has a large foundation dedicated to disparity reduction, and his backing will also increase the possibility that it will be realized.

One approach to make computer use more accessible is to plug cell phones into TVs with a cheap adaptor and add a keyboard. This can turn cell phones into computers. TVs also have high penetration rates regardless of race/class.

This “cell phone + TV” computer is a strong candidate given high current penetration rates and Microsoft’s funding. A Microsoft press release described the possibility in this way:

Bill Gates, Microsoft's co-founder and chairman, demonstrated a mockup of his proposed cellular PC at the Consumer Electronics Show in Las Vegas earlier this month (1/30/2006), and he mentioned it as a cheaper alternative to traditional PC's and laptops during a public discussion here at the annual meeting of the World Economic Forum.

Craig J. Mundie, Microsoft's vice president and chief technology officer, said in an interview here that the company was still developing the idea, but that both he and Mr. Gates believed that cell phones were a better way than laptops to bring computing to the masses in developing nations. "Everyone is going to have a cell phone," Mr. Mundie said, noting that in places where TV's are already common, turning a phone into a computer could simply require adding a cheap adaptor and keyboard. Microsoft has not said how much those products would cost.

Mr. Mundie said there was no firm timing for the cell phone strategy, but that the company had encouraged such innovations in the past by building prototypes for consumer electronics manufacturers.²⁰

Microsoft’s strategy did not explicitly include health software until July, when it acquired Azyxxi – an advanced system for integrating multiple disparate sources of medical information on the same patient. This software is focused on hospital emergency rooms – a high end application. But, given the Gates Foundation’s keen interest in health issues and the increasing awareness of the link between health,

wealth, and development it seems possible and reasonable that a focus on integrating capacities for low income settings is likely to emerge from Microsoft or the Gates Foundation.

CITRIS

Researchers at the University of California Berkeley and three other UC schools have proposed another technology-driven disparity project called CITRIS. These researchers argue that while there are thousands of individual projects that aim to bring information and communication technology to developing regions, nearly all of these depend on existing hardware and infrastructure developed for affluent regions. The imported technologies fail to address the challenges of cost, deployment, power and support for semi-literate users.

CITRIS proposes to develop the key technologies and infrastructure to enable these projects and other new applications that were previously intractable. CITRIS defines its goal as not just understanding specific information and communication technology applications, but also demonstrating that the underlying architecture of these applications truly helps developing regions. Technologically, CITRIS's strategy is to attack the key challenges of cost, power, deployment, support, and literacy.

The project promises to deliver: 1) novel low-cost, low-power devices; 2) a new approach to low-cost networking based on intermittent connectivity (rather than persistent connectivity as in the Internet); 3) a user interface toolkit to support poor literacy via novel speech recognition, and a variety of sensors for environmental and health applications; and 4) a three-tier architecture with proxies and data centers to support low-cost devices with more functionality, easier development, over-the-wire reprogramming, and usage monitoring for social science research.

Supporting partners include Intel, HP, IIT Delhi, Markle and Grameen Bank. While technologically, focused, the project has also included social science faculty to push the work toward pragmatic solutions to problems.

While CITRIS is focused on developing countries, it is possible that similar capacities, at still relatively low costs, might become available in the U.S. if they are able to develop such technology and systems,

Low cost cell phones: Insights and Implications for the DRA Project

There seems to be a recurring pattern that points to the development of low cost options for the world's poor but emerging market. However, these options are generally not directed towards the underserved in the US. A possible role for the DRA Project is to work to make these advances available in the US.

At the same time, basic cell phones in the U.S. have a significant user rate in the traditionally underserved populations. As explored above, this could mean that cell phones are not following the traditional diffusion curve but rather have a more equitable diffusion pattern.

There are clear trends towards ever cheaper cell phones and the miniaturization of both cell phones and health monitoring technologies. Miniaturization can simultaneously push to increase expense with the cost of the technological development and to lessen expense through decreased material costs. Making

miniaturization of health monitoring technology inexpensive is another possible area where the DRA Project can focus its attention.

Infrastructure and Services

Cell phone handsets are only the first of three components needed to reduce disparities. The infrastructure to communicate and the service packages sold for use with the handset are the other two.

In the US it is possible that by 2016 most, if not all, parts of the country could have free or low cost wireless access at high speeds. If this is the case, then increasingly the internet interface of choice will be the telephone, this is already happening for the many individuals who use VOIP services such as Skype and Vonage. These services provide free internet user to internet user audio calls. Increasingly, they are also offering video and multiple user conference calling. Some even offer the ability to call from your computer to regular landline or cellular phone numbers for a small monthly fee.

In considering the possibilities for change in the cell phone infrastructure and services, there are three developments that are particularly relevant here: WiMax, and calls for free internet access, or for use of the radio spectrum for competing services.

WiMax

WiMax (Worldwide Interoperability for Microwave Access) is an emerging wireless set of standards (IEEE 802.16) and implicitly includes the infrastructure technologies which use those standards to enable delivery of last mile wireless broadband access, in many settings as an alternative to cable and DSL. Some technology companies assume that WiMax is the future of internet access.

WiMax is, in the opinion of many technology firms and research group, the future of internet access. It is structured as a series of central hub towers, each with the capability to “transmit up to 280 Mbps with individual signals ranging up to 70 Mbps. WiMax uses low frequencies in the 2 to 11 GHz range.”²¹ WiMax is also capable of transmitting a signal up to a distance of 31 miles, non line of sight. Intel is developing a WiMax chip, as it did for Wi-Fi. Devices in the years ahead are likely to include both types of chips. Public safety groups and police departments are beginning to test WiMax networks to replace their current systems. For cities interested in creating free internet access, WiMax, when it is ready, could provide a less costly option.

Cell phone like handsets, equipped with WiMax chips might use that internet access for telephone services – as noted, enabling free or low cost telephone services.

Widespread use of WiMax is expected by some as soon as 2010.

Major new and existing players are likely to accelerate WiMax use. Clearwire is one. Craig McCaw invented a cellular phone network in the 1980s and later sold it to AT&T. Some observers think that he could do much the same to today’s cable, satellite, and telecom players by providing a cheaper alternative to the broadband services they currently offer. His company Clearwire Corporation has over \$1Billion in investments, including major investments from Intel and Motorola. Using WiMax

infrastructure that is much lower cost than traditional networks, Clearwire can likely afford to offer a nationwide mobile service for as little as \$25 a month²². That would be for phone and internet services.

CyrenCall

Competition for the spectrum is also coming from a proposal to create integrated public safety/first responder national network, as the following excerpt highlights:²³

Morgan O'Brien, chairman of CyrenCall Communications has a plan to create a new nationwide first responder network using the (public) 700 MHz frequencies that would otherwise be auctioned off in 2008.

The plan calls for a reallocation of 30 MHz in the upper 700 MHz band of spectrum, which is half of the spectrum scheduled to be auctioned in 2008 for commercial use. At 700 MHz, signals can travel 30 miles, penetrate walls, and be sent and received without a direct line of sight.

This network would connect all communities -- urban and rural -- in the event of an emergency, and it would have a satellite component so responders could stay in touch even if land-based systems failed.

M2Z

A somewhat less likely proposal, but one that would give free internet in exchange for access to a piece of spectrum, comes from the company M2Z. M2Z asked the FCC to grant it a 15-year license so it can offer free broadband service that would be supported by advertising. Consumers would have to buy a "low-cost" receiver to use the service. Faster rates of broadband access would also be available for a subscription.²⁴

M2Z promises to use this spectrum to provide free, advertising-supported 384 Kpbs/128 Kpbs Internet service to 95 percent of the U.S. population alongside premium offerings of about 3 Mbps. They promise to deploy immediately and guarantee to meet deployment targets over a 10 year period, starting with 33 percent coverage within three years of the license grant.

What they offer in return is five percent of gross receipts for their premium service, which will run about 3 Mbps.

M2Z, like CyrenCall, faces major hurdles: these portions of the spectrum are typically sold at auctions and raise billions for the Federal Treasury and many established companies will work to prevent these from being put in place.

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