Putting Communications Access in the Palm of People's Hands: A Model to Drive Faster Economic and Social Growth

A Paper for Alcatel-Lucent and the World Economic Forum

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In developed markets, 80% of people have a mobile subscription. The number drops by half in developing markets.

Why should we care?

Because a ten percent increase in mobile penetration leads to a 1 percent increase in low-medium income GDP. That's about 160 billion dollars added to the global economy. Mobile also has the potential to change the way people live. Raise the Human Development Index by 0.92 percent and 440,000 more children have access to education, and average life expectancy goes up by 15 months. We can measure, in tangible terms, the impact of mobility on economies and on the human development index. By putting into place "lighthouse applications," that is, applications that demonstrate the power that mobility brings to the market, the adoption of mobile services – and their powerful social impact - can be dramatically accelerated. Bottom line: Having access to mobility should be a basic human right.

Three things are required to make this happen.

- **We must make available a near-zero cost mobile device** – in effect a $1 device or a device that costs less than 5% of income. This may seem like an impossible task, but the bar needs to be set.

- **Green investment in infrastructure is key**. It is crucial to rethink the current model for infrastructure investment in an energy and cost-efficient fashion. In cities, capacity bottlenecks will emerge that require new sources of revenue to fund expansion. Rural areas, on the other hand, must be based on green models of deployment, including alternative energy options.

- **Scalable applications that support basic human needs** must be developed and deployed. Social innovations occur in all corners of the world, but the challenge is scaling them. Education, healthcare, and banking applications are important examples, but must be simple and locally relevant. It is also important to bridge the gap between those who have mobile access and those that don't: In some cases, using a village-centric versus people-centric approach such as trusted elders in a village is a good way to bridge the gap. Addressing the gender gap is equally an important issue in bringing mobile to all.

The World Economic Forum has pulled together a Global Agenda Council (WEF-GAC) on the Future of Mobile Communications. Their goal: make sure everyone has Internet access by 2015[1]. Consider this: The number of mobile devices in use globally has now grown to 5 billion, and the number of those devices capable of accessing the Internet is expected to reach 1.82 billion by 2013.[2] This is an aggressive and (hopefully) sustainable growth rate, but is it insufficient to meet the 2015 goal for ubiquitous access? What are the challenges that stand in the way of achieving it? How can they be addressed? How can individual countries and regions quantify the economic and social benefits of extending connectivity to its entire population? After all, people in emerging markets are only half as likely to have access to mobile communications as those of developed countries,[3] and fewer than 10 percent have Internet access, far below the global average of 23 percent.[4] Why is that?

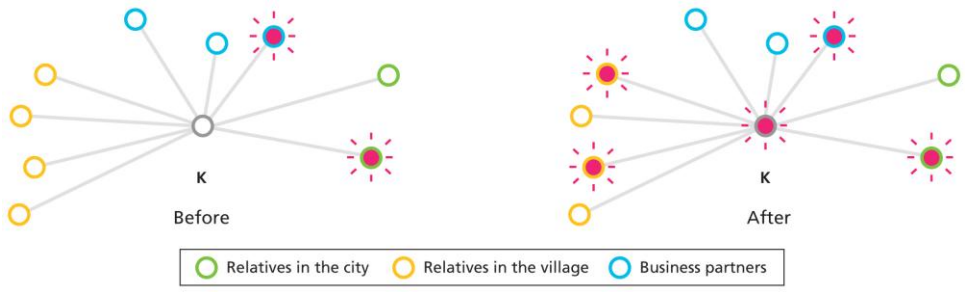
We asked a team of researchers at Bell Labs, the WEF-GAC and over fifteen experts in subjects ranging from public policy, economics, social development, technology and business. They did in-depth studies on Kenya, Bangladesh and Venezuela that validated their belief that the widespread introduction of mobility to a region changes the way people live in numerous positive ways.

[1] The newly renamed Telecom Industry Global Agenda Council envisions a world in the next five years in which everyone is connected with sufficient access to an Internet-based, open ecosystem of information, devices and applications through incentives for technological, social and business innovation.
[2] http://www.gartner.com/it/page.jsp?id=1278413
[3] Ovum.
[4] ITU, 2009.

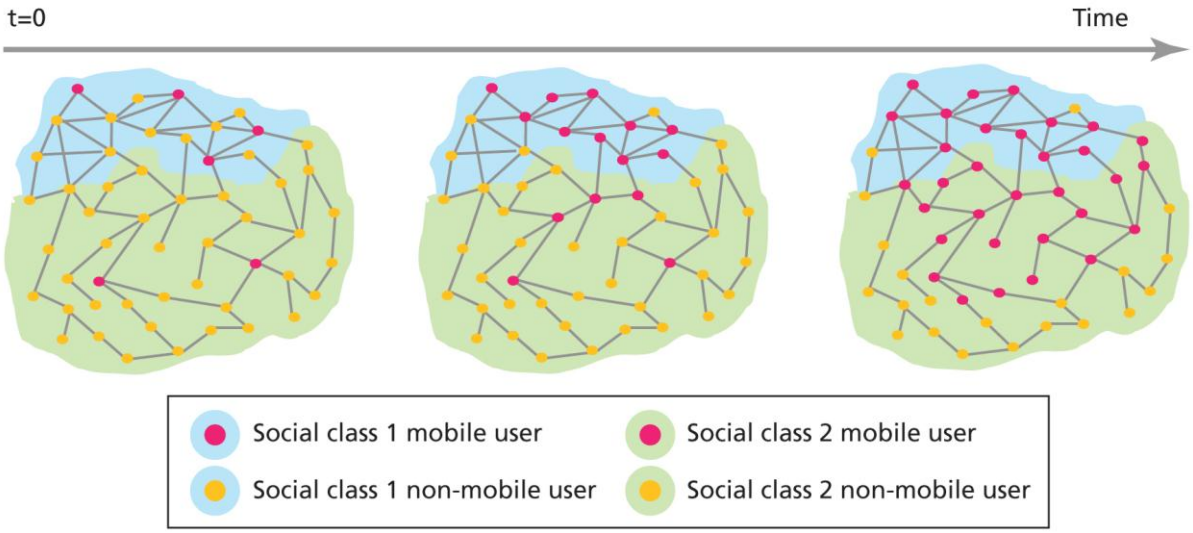
The Bell Labs Bootstrap Model

As part of their research, Bell Labs created a framework for assessing the cost of entry for an operator looking to enter into the developing world. The model first computes the incremental network build-out necessary to achieve ubiquitous access, given the coverage provided by existing networks. The build-out schedule, which typically spans multiple years, is then divided into yearly values so that the operator can realistically predict the cost they will encounter during the early phases of the project. The good news, of course, is that the nations of the developing world represent 86% of the world's population, and they are dramatically underserved. If we make a concerted effort to keep the cost of service and equipment low, and provide compelling applications, this could well be the largest long-term market ever encountered.

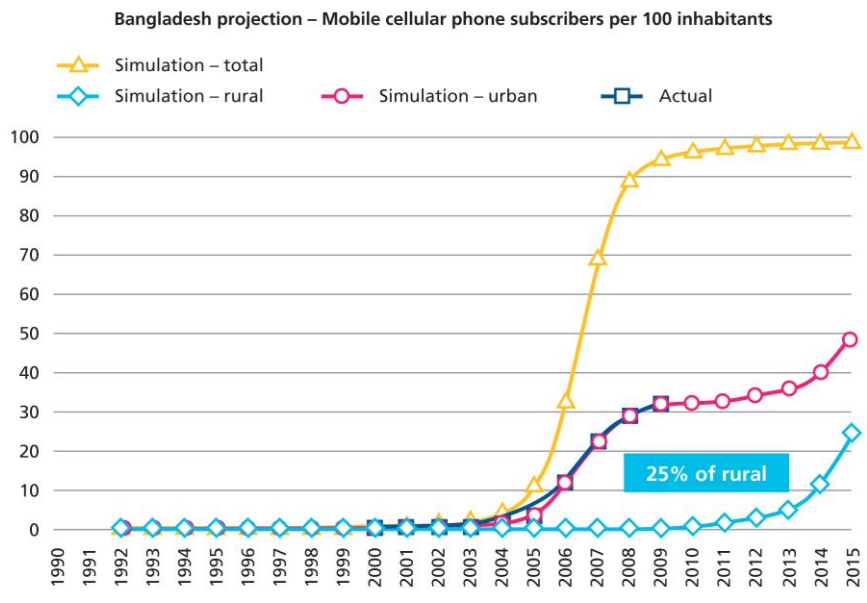
The heart of the research conducted by Bell Labs is their Bootstrap Model, which incorporates the impact of a set of factors that enrich our understanding of the mobility adoption curve. These factors include the affordability of the service, which might be improved by lowering prices or increasing disposable income over time; the heterogeneity of the population, including the presence of distinct social groups with different levels of income, age structure or location (rural vs. urban); the presence or absence of early adopters in each of the social groups; the strength of interactions between members of the various social groups; and finally, changes in the utility derived from the service through the emergence of new applications and usage options. These characteristics make the model a powerful tool to analyze the penetration of telecommunication services.



Here is an example of the model. A person considers buying a mobile phone. However, no one in his or her peer group owns one, so the social value for this person, 'K' in our example, is near zero. Then, two neighbors or family members buy mobiles, and suddenly the compulsion to own a device increases because of the opportunity to actually derive social value from using it. 'K,' then, buys a device (diagram above, left), and begins to influence others. Soon, an expanded number of K's peers have mobiles (above, right). This is the Network Effect at its best. When existing subscribers influence others to buy, the Bell Labs' Bootstrap Model is at work.



The diagram shown above illustrates graphically what happens when the Network Effect emerges in a new market. On the left, we see a market largely dominated by non-mobile users. But watch what happens: As the number of mobile users grows, they begin to influence those who don't have service (middle), and the number of mobile users grows. Pay particularly close attention to the role played by the connections here: If it were not for the growing number of interconnections that exist among the mobile users, their ability to influence the non-subscribers would be immensely more difficult. Notice also that the influence we are describing transcends social class: While the variables described earlier affect the speed at which the change takes place, they do not stop it.

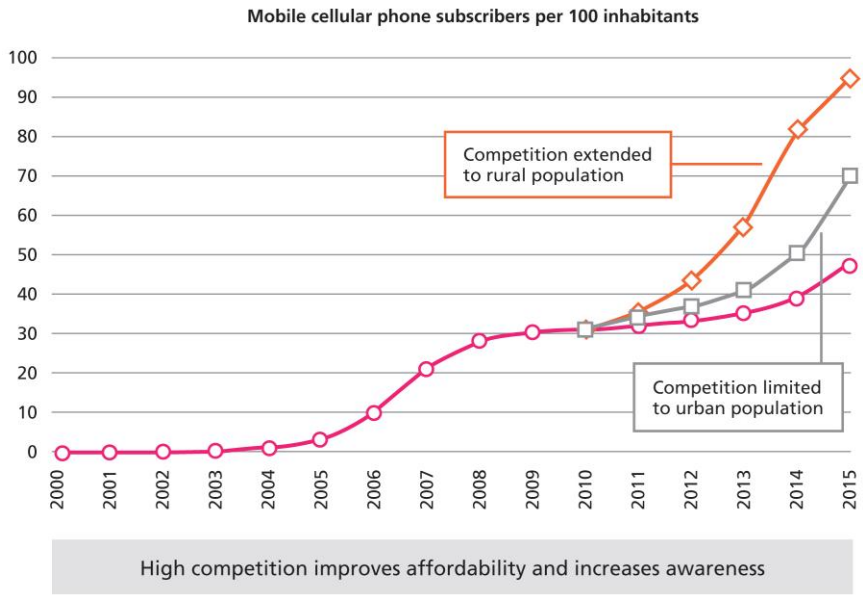


It is also true that as mobile connectivity increases, the social networks begin to cross geographical boundaries. According to Bright Simons of mPedigree Networks, the provider of innovative mobile healthcare applications in Africa, "When people across multiple regions are connected, the peer groups that form tend to be widely scattered, and people's buying decisions are influenced not only by others in their neighborhood, but by peers from other regions as well." This is an important point. Connectivity enables the peer groups identified in the Bootstrap Model to form dynamically. Once people connect to the network, they can be members of several peer groups, and each peer group can span the entire world.

A Test Case: Bangladesh

To validate the accuracy and applicability of the model, Bell Labs selected a test case. In this case the country chosen was Bangladesh, because it offers all of the challenges that the model addresses: a large, underserved population, health and education challenges, a strongly motivated workforce, and a growing urban population with reasonable connectivity. The country represents the key challenge facing the entire developing market: Cities with enough infrastructure in place to make it likely that they will meet the 2015 goals of universal connectivity, but a large rural population that won't come close without some kind of intervention.

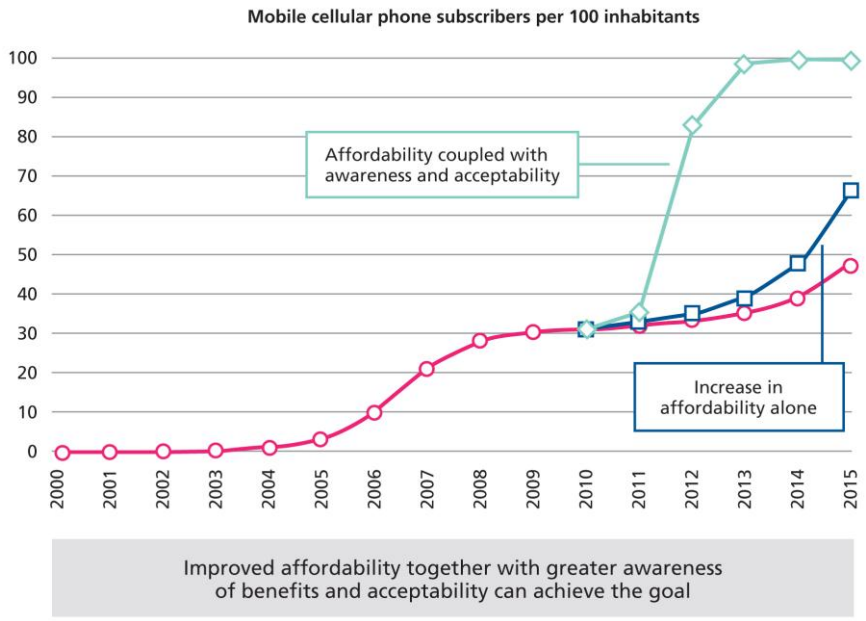
The graph shown above represents the baseline for Bangladesh. Clearly there is mobile growth, but it isn't particularly stellar. However, when technology, government and business model innovations are introduced to (in the case of the next graph, below) reduce the cost of the handset by an order of magnitude, service penetration goes from 25% of the rural population to radically higher levels, resulting in dramatic increases in business growth and more widely available education and healthcare.



High competition improves affordability and increases awareness

Another factor for improved penetration that the study identified is the impact of a liberalized regulatory model. When competition is introduced into a rural market, service affordability improves, awareness of available services grows, and the market finds itself energized by the battle for the customer's wallet between the competing parties. The diagram at left illustrates this nicely: **When competition is limited to the urban market, the growth is impressive, but when it is further extended into the rural areas, strong growth results.** Government's role in bringing about higher levels of mobile penetration is important.

One of the most telling graphs from the Bell Labs study is shown at right. When affordability was increased in the model, the uptake rate increased modestly. When it was combined with an aggressive awareness campaign to influence the market to buy, the result was nothing short of extraordinary: A self-validating market that is its own best catalyst for adoption and growth.



But let's not stop with Bangladesh: The model was also applied to Venezuela, Kenya, and Laos, with equally indicative results. In Kenya alone, putting technology into the hands of the rural population led to 36% higher GDP growth and 443,000 children suddenly having access to education. In all three cases the government of the country wanted to expand the reach and impact of technology, clearly recognizing that the only way to do is to scale the availability of the applications that make the technology relevant to the population and ensuring that the technology is economically accessible by the BOP population. This is a challenge in and of itself. The network must be able to meet the growing demands of the urban population, which will soon grow to exceed the capacity of the in-place network, as well as the widely scattered, low-income rural population. The point is that the model works: it accurately predicts, in real, measurable ways, the impact that mobility introduction has in developing world countries, making it possible for governments and investment agencies to assess the cost – and benefit – of technology adoption and deployment.

Rethinking infrastructure investment: urban and rural challenges

To help with the assessment process, the Bell Labs model also addresses the economic impact of deploying a reliable, cost-effective network. Two distinct issues affect the ability to do this: adequate geographic *coverage* in rural areas; and adequate network *capacity* in urban areas. As mobile applications become a reality, particularly in the cities, networks will stagger beneath the load. So scalability is a critical factor to ensure that they can be delivered en masse and that the network can scale and provide coverage in lockstep with that growth.

Sidebar: In a recent study conducted by Alcatel-Lucent[i], the impact on the global network of a growing population of mobile devices was studied. The results were stunning. In 2010, the average number of devices per square kilometer is 400. By 2015, however, less than five years from now, that number will increase 32-fold to 12,800 devices in the same geography – bringing with it an equally extreme increase in the traffic load that the network must carry. And considering that it takes significant lead time to acquire space for and to build the necessary infrastructure required to handle that kind of growth, the time to begin doing so is now.

	2010	2015
Number of devices	40	12,800
Daily traffic per device,	8	8,192
Total daily traffic per sq. km., Mb	3,200	104,857,60

Creating the Near-Zero Cost Device

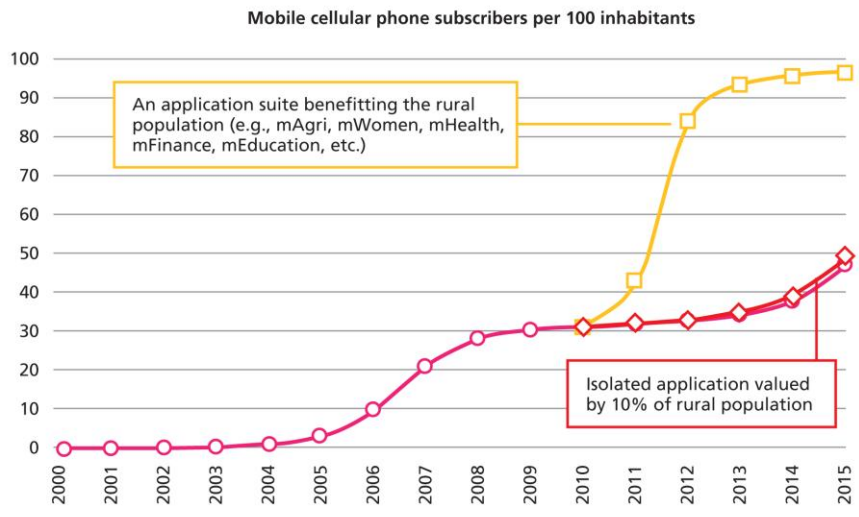
The first issue that must be addressed is access to a near-zero cost device. The combination of handset cost and monthly service charges represent an undefeatable barrier for many. Even at the lowest currently prevailing usage charge, mobility is out of reach for most. However, when the price of mobile phone service falls below five percent of household expenses, it becomes a realistic number.

So what can be done to make this happen? The answer requires the combined efforts of device manufacturers, content providers, operators, and government agencies. Device manufacturers and content providers, for example, can develop extremely low-cost, simple-interface devices and populate them with lighthouse applications to catalyze usage. Network operators can work to develop low-cost services designed specifically for low-income households. And government agencies can offer reduced taxes on mobile devices and put into place policies designed around the belief that access to mobility is a fundamental human right. Bright Simons of mPedigree Networks, makes the case well. "We must explore ways of reducing the cost of a mobile phone to the end user. One approach? The government distributes free handsets which carry a SIM card with their national ID so that subscribers can access mGovernment applications."

Addressing Infrastructure Investment in Rural Areas: The Green Alternative

Delivering mobile service to a sparse population that is widely scattered across a broad geography is complex and expensive. In fact, one of the greatest barriers is the ability to deliver it cost-effectively, given that rural regions lack the population densities found in urban areas that make it possible to deploy expensive infrastructure and amortize its cost across a large population. As Ben Verwaayen, CEO Alcatel-Lucent says, "Green is good for the pocket, for the environment and it's necessary to go rural ." What is needed is a combination of energy efficient and affordable networks as a solution to rural deployment. Some solutions to this challenge are technological; others, however, are legislative.

Several technological innovations offer great promise in terms of curbing emissions and reducing the environmental impact of technology, while simultaneously addressing cost factors. Among them are smart network management systems, the incorporation of improved energy management algorithms, low-cost wireless services that rely on a hierarchy of cells, energy efficient hybrid wireless networks that incorporate green products, renewable energy solutions, and the smart grid concept.Time Division Long Term Evolution (TD-LTE) offers a revolutionary radio design that not only provides greater reach and therefore coverage than other radio technologies, but is so spectrum and energy-efficient that it slashes the power requirements and operating expenses (OPEX) for operators by as much as 60%.



When mobile applications target a larger critical mass of the rural base, technology adoption percolates much faster

Network performance modeling done at Bell Labs shows that the evolution from a traditional base station model to a self-organizing smaller cell model can reduce the cost of transmitting data through a network *by a factor of 100*. And there is yet another benefit. Alcatel-Lucent's self-organizing small cell model also supports third-party application-programmer interfaces (APIs) which allow application developers to plug into the network and deliver their applications to customers on the same network, thus bringing innovation and low-cost

capability to the rural population. This model also helps with application scalability, by providing broader reach for application developers.

Clearly, then, a low-cost handset and affordable services, coupled with government involvement to reduce cost through the introduction of competition or a forward-thinking regulatory model, can do a great deal to catalyze the growth of mobile services in the developing world. But the third requirement is equally compelling: The introduction and use of carefully designed applications.

The Power of the Application

One of the key observations that emerged from the Bell Labs modeling effort was that when mobile applications appeal to a large portion of the rural base, the adoption rate of the technology increases at a much faster rate. The reason for this is fairly straight-forward: as long as the applications are relevant to the population that they serve, resistance to their introduction will be low, and indeed, the rate of adoption will accelerate as the number of people using them increases – again, the Network Effect. As part of the Alcatel-Lucent Bell Labs study, a suite of applications was modeled for rural Bangladesh. These mobile applications included mAgriculture, mWomen, mHealth, mFinance and mEducation, and were designed to offer tangible benefits to the rural population at which they were targeted. In fact, they directly served 80 percent of the rural population — and radically accelerated mobile adoption. On the other hand, the introduction of a single application had much less impact, as shown below. In fact, a trend that seems to be emerging is to design the applications to deliver value to a large population by securely relying on a government National Identity database.

"The teledensity in Bangladesh has increased dramatically, and the impact has been remarkable," says Muhammad Ibrahim, Founder and Chairman of the Centre for Mass Education in Science in Bangladesh. "The country has now seen the first wave of the mobile revolution. People, even those with minimal literacy skills, are not afraid to use gadgets any more. So Bangladesh is now ripe for the second revolution that will bring in applications [such as] mHealth, mAgriculture, smarter disaster alert systems, and smarter security applications. But service providers need to create more interesting applications and offer them in a more organized way so that more people can benefit from them. They should also offer increased Internet connectivity through mobile phones, and provide off-peak discounts to enable greater adoption."

Banking is one of the applications that is experiencing serious growth at the moment, thanks to mobile technology. According to Nik Nesbitt, CEO of Kenya-based contact center KenCall,, he believes that multiple mobile applications may have to be provisioned in order to fully convey the value of mobile phones to the rural population. For example, in Kenya Equity Bank and telecoms partner Safaricom have collaborated to offer M-KESHO, a mobile banking application that allows subscribers to engage in routine banking transactions via their

mobile phones. The service has become quite popular; the venture is opening somewhere between 5,000 and 10,000 accounts daily. But those represent the tip of the proverbial iceberg. In Kenya, the analysis shows that telecommunications infrastructure investment and wide adoption of mobile payment, mobile banking and mobile health applications alone can increase the GDP growth rate by 36 percent. In human development terms, this boost to the economy would result in an estimated 443,000 new students enrolling in primary and secondary schools, an increase of 2.9 percent. Ubiquitous access to mobile health applications can lead to a 2 percent increase in life expectancy by reducing fatalities due to epidemic disease and infant mortality.

What we're talking about here are "lighthouse applications:" applications that may not seem particularly impactful on their own, but that act as catalysts for adoption. M-PESA, a microfinance system in Kenya, and mPedigree, an Africa-based healthcare delivery support system, are examples.

An Aside: Bridging the Gender Gap

One of the most glaring discrepancies in the developing world is the gender gap that exists with regard to mobile phone usage. According to an extensive study led by Dawn Haig-Thomas of the GSMA, 300 million fewer women than men subscribe to mobile phones, implying that two-thirds of all future subscribers may very well be women. As a consequence of this burgeoning reality it is crucial that operators take steps to develop a clear understanding of applications that are most relevant to women, and invest a respectable percentage of their research and development budgets on women-specific applications.

The GSMA mWomen Programme, whose spokespeople include Hillary Clinton and Cherie Blair, recently announced the launch of the mWomen Base of the Pyramid (BOP) App Challenge, a competition designed to address the significant demand for innovative application designs targeted at the specific needs of women in developing countries. The challenge has two tiers. Tier one will reward an application designed for a low-end device, while Tier 2 will reward applications designed for smartphones. The rewards are significant: As much as $15,000 will be given to the winner in each category. Mamakiba, for example, is a mobile-based budgeting application that helps low-income pregnant women save and prepay their prenatal care and the costs of childbirth. Under the banner of education, literacy has been determined to be a high-demand item. Handsets that come pre-loaded with applications will help; in Bangladesh, more than 300,000 people have taken advantage of a new program that teaches English very effectively via cell phone.

Final Thoughts

Let's be clear: When the penetration of mobile service in the BOP sector rises by ten percent, GDP increases by one percent. In real terms, that means 160 billion dollars added to the global economy. It means giving education to 400,000 children to whom it would otherwise be denied.

It means bringing healthcare to rural areas, extending life expectancies, catalyzing business growth, expanding the reach of government services – in essence, fundamentally changing the way people live.

Three criteria must be met if the impact of mobility in the developing world is to be achieved. We **must** make available a near-zero cost mobile device. We **must** create solutions to the coming capacity bottlenecks that will plague cities and rely on green investment in rural infrastructure. And finally, we **must** encourage the development of scalable applications that support basic human needs.

The Bell Labs Bootstrap Model is a powerful economic tool that can demonstrate the power of widely deployed communications technology in a rural, low-income environment – or, equally important, the staggering impact of *not* deploying it. When used, the model also demonstrates that the three actions listed above must be undertaken on a broad scale if ubiquitous connectivity is to be achieved by 2015. The manufacturing industry, governments, and operators must collaborate to create and offer, on a wide scale basis, a near-zero cost access device. This is crucial for widespread acceptance and use of mobile services. Operators must work closely with manufacturers to come up with an infrastructure model that will (1) catalyze the deployment of service in the rural marketplace, and (2) meet the burgeoning traffic requirements of cities. Equally important to this particular effort is a focus on sustainable and cost-effective power technologies such as solar and wind. Finally, efforts must be made to encourage the development and deployment of scalable applications that will meet the critical needs of the developing world's population in terms of relevant use of the mobile device.

Green initiatives are already underway in some regions in the form of biomass-fueled power stations, solar-charged handsets and other innovations that will help the BOP sector overcome the challenge of a non-existent or undependable power grid. And activities are taking place that encourage and reward the development of third-party applications that will address the very real challenges that face citizens of developing world nations.

To meet the WEF-TI-GAC goal of ubiquitous connectivity by 2015, the time to act is now. Less than five years remain before 2015, and the social and economic benefits of this aggressive goal more than equal the cost to make it happen.

Success, therefore, requires a global effort to bring together investment, interoperability, innovation, and education, which together combine to create a perfect storm of opportunity for the developing world. The challenge is not a technology problem, but technology, in combination with innovative financing and forward-looking government policies, can realize the dream of the WEF: To connect the world by 2015.

How mobile phones are changing lives (Sidebar)

- Low-income entrepreneurs with no office or storefront have gained a "fixed address," their phone number — allowing contact from more customers.
- Fishermen in India can negotiate prices with different buyers, increasing their profits.
- Young women in Pakistan are learning to read by receiving daily text messages in Urdu, on a variety of topics.
- Agricultural workers in rural Uganda are discovering new techniques and practices through low-cost SMS messages.
- Indian farmers get a daily weather report that helps them gauge the most efficient use of water.
- Public health workers in South Africa answer anonymous questions about AIDS using text messages.
- In Nigeria, consumers can use text messaging to check if their medications are genuine.
- In Kenya, people without bank accounts have a safer, easier way to make payments — without carrying money over long distances on overcrowded public transportation.

[i] The Mobile Internet Revolution. Luis Lucatero; Commerce in France, Number 77, Fall 2010.