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# MOBILE COMMUNICATIONS: ECONOMIC AND SOCIAL IMPACT

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## **Abstract**

The ubiquitous cell phone is often portrayed as the scourge of civilized society: rude callers on streets, in malls and offices, disturbing those around them with loud talking, school kids constantly texting in class, drivers whose attention has wandered during a cell phone conversation causing accidents, “crackberry” addicts who check their e-mail during real-world conversations, the list goes on. Is this an invention whose result has been to make us all worse off, like Internet spam and phishing attacks?

In this paper, I informally survey the rise and impact of cellular technology, both in the US and the world. I find that the reach and the speed of its worldwide diffusion has exceeded even that of the Internet, and certainly with far more reach and speed than the personal computer. Mobile’s economic and social impact has been unprecedented, especially in the developing world where it has been a boon to economic development. While many in the US focus on expanding the diffusion of the PC both domestically and worldwide, as well as expanding the availability of broadband connectivity, I argue that while PC-broadband architecture will continue to be important, the terminal device of choice for most people on this planet will be the mobile, accessing information services over a wireless connection. Mobile telephony is, I believe, the highest impact communications technology of the last 50 years, rivaled only by the Internet.

# MOBILE TELEPHONY: ECONOMIC AND SOCIAL IMPACT

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## 1. Introduction

The rapid growth of mobile phone (“mobile”<sup>1</sup>) ownership and usage has generally been viewed somewhat negatively, at least in popular culture, in the US and most OECD countries. White collar workers bemoan that they are now tethered 24/7 to their jobs by their mobiles, drivers point with alarm to accidents caused by others driving while talking on their mobiles, parents complain that their children spend much of their time (in school and at home) talking or texting on their mobiles, and many complain of loud talking by mobile users in public spaces such as streets, busses, trains and restaurants. In addition to the many TV and press stories detailing the social problems with mobile usage, there are websites devoted to stamping out mobiles (or at least teaching users good manners)<sup>2</sup>, and even the Vatican has weighed in, suggesting that mobiles may be bad for the soul.<sup>3</sup> With the prevalence of such negative attitudes, it is surprising that anyone actually buys and uses such anti-social devices.

And yet, mobiles have become the single most ubiquitous electronic technology the US has ever seen, and the single most ubiquitous technology the world has ever seen. Currently, there are over 4.1 billion active mobiles, representing 61% of the world’s population. Worldwide, the annual growth rate of mobile exceeds 20% and shows no sign of flagging. No other technology is even close. This extraordinary market outcome suggests the benefits of mobile telephony must be very great indeed.

This paper presents no new data, nor economic models. I simply array the known facts of mobile telephony deployment and growth against that of other, more favored technologies and conclude that is the dominant information technology in the world, and its dominance will increase over the foreseeable future.<sup>4</sup> Calls for a “laptop for every child” and “broadband to every home” are being met --- by mobile devices, performing these functions traditionally carried out using fixed technologies. Broadband and PCs

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<sup>1</sup> I use the term “mobile” to refer to any mobile device capable of voice or data communication, which can be carried in a pocket, handbag or belt case. I do not include laptop computers or PDA-only devices.

<sup>2</sup> See < <http://www.nophones.com/> >

<sup>3</sup> Beaumont, Claudine, “Vatican warns mobile phones are bad for the soul,” THE TELEGRAPH, Nov. 27, 2008, at < <http://www.telegraph.co.uk/news/newstopics/religion/3531418/Vatican-warns-mobile-phones-are-bad-for-the-soul.html> >. The actual statement of the Vatican spokesman is rather more nuanced than the headline, and in fact the Vatican has used modern electronic technology (such as mobile) to communicate with the faithful.

<sup>4</sup> Related work is reported in the excellent paper by Kalba, Kas, “The Global Adoption and Diffusion of Mobile Phones,” PROGRAM ON INFORMATION RESOURCES POLICY, Harvard University, Dec 2008, at < [http://pirp.harvard.edu/pubs\\_pdf/kalba/kalba-p08-1.pdf](http://pirp.harvard.edu/pubs_pdf/kalba/kalba-p08-1.pdf) >. The Kalba paper focuses on the drivers of adoption of mobile worldwide.

will continue to be available, of course. But increasingly, mobile will become the portal of choice to the Internet for most of the world's population. The "digital divide" will be conquered, for the simple reason that with mobile telephony in OECD countries, there is no digital divide today, nor will there be in the future.<sup>5</sup>

In Section 2, I examine the current situation in the US, focusing on growth of voice subscriptions and usage in comparison to wireline telephony. The extensions of voice mobile into various forms of data services are also discussed. In Section 3, world trends are reviewed, particularly in the developing world. I specifically compare the deployment and growth of mobile compared to PCs, broadband, wireline and Internet users. In Section 4, I review both empirical results and anecdotal evidence regarding the substantial impact of mobile telephony on the economies of developing countries, and the pivotal role of mobile telephony as an engine of economic development. Section 5 concludes the paper.

## **2. Development of the Mobile Market in the US**

Mobile telephones have been available in the US and Europe since the 1960s, as large units, generally trunk-mounted in automobiles; high costs and limited capacity severely constrained their market deployment. With the advent of cellular architecture in the 1970s (in the US, Europe and East Asia), so-called 1G analog mobile telephony began. Mobiles dropped significantly in price and weight, as did the cost per minute of mobile usage. In the mid-1990s, digital cellular phones were introduced in the US, following the first auctions of spectrum to enable these services. The number of cellular operators increased substantially, and the market for digital ("2G") services entered a period of very high growth. During the early 2000s, the pace of new device introductions increased, leading to higher performance, lower weight and greater battery life. Prices continued to fall, and new data services, collectively called "3G" services, came on stream.

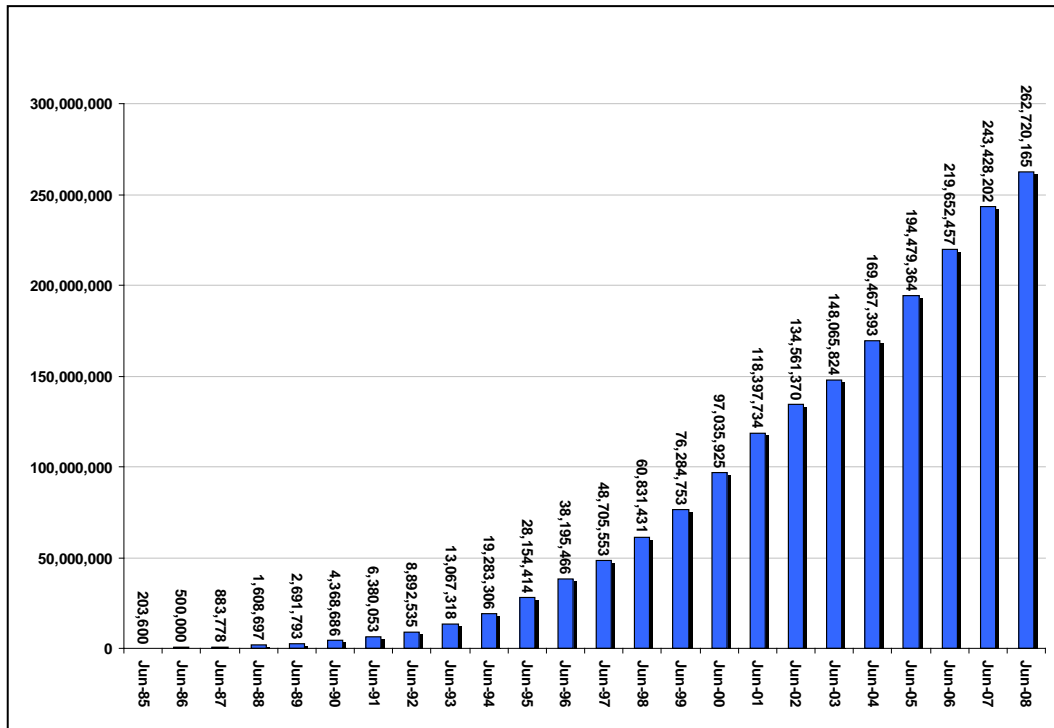
The extraordinary growth of mobile subscriptions in the US is shown in Figure 1, an annual growth rate of over 25%. Figure 2 shows a strong growth in minutes of use per subscriber over the last decade, coupled with a strong decline in average revenue per minute. Total voice usage in the US is over 2 trillion minutes per year.<sup>6</sup>

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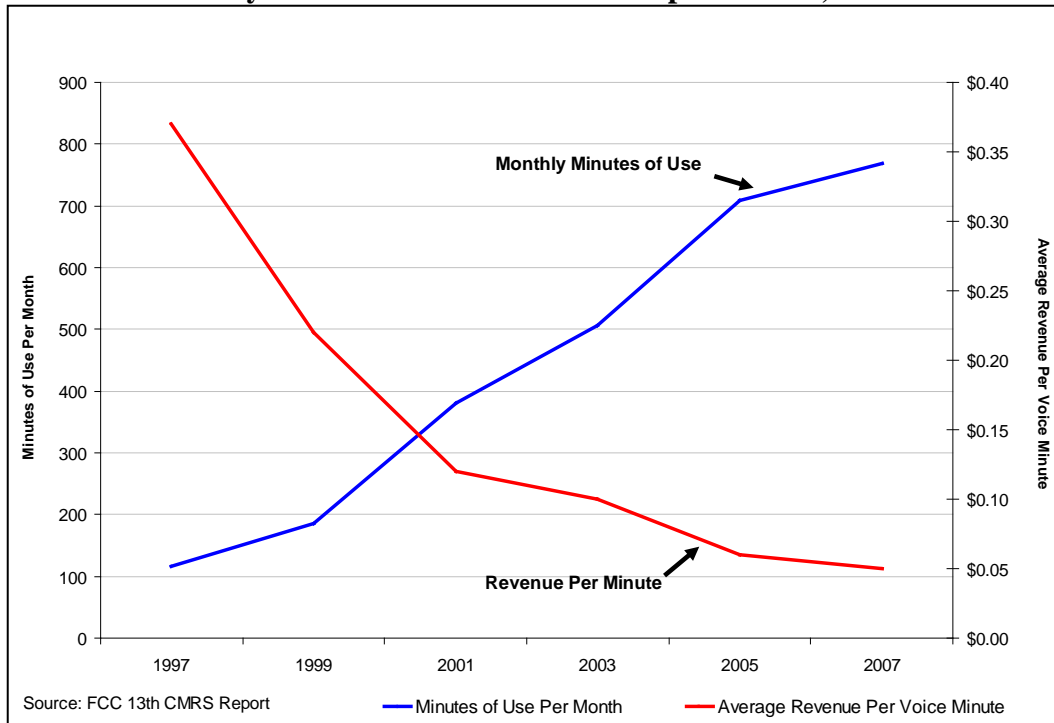
<sup>5</sup> In developing countries, penetration rates are rather lower than in OECD countries, but growth rates are significantly higher. This suggests that in these countries, we are witnessing a "digital lag" rather than a digital divide.

<sup>6</sup> Charts and data from Roche, Robert, "National and Rural Wireless Trends: What Does the Data Show?" Feb. 2009, CTIA.

**Figure 1**  
**US Wireless Subscribers, 1985-2008**



**Figure 2**  
**Monthly Minutes of Use and Revenue per Minute, 1997-2007**



Surveys reveal that mobile users are growing ever more attached to their devices. Figure 3 shows that of the various electronic systems (Internet, wireline phone, television, etc.) available to customers, mobile is the service that most would find “very hard to give up.”<sup>7</sup>

**Figure 3**  
**Intensity of Use**

<b>Those who say it would be very hard to give up ... (among those who use each device)</b>			
	<b>2002</b>	<b>2006</b>	<b>2007</b>
Cell phone	38%	43%	51%
Internet	38	38	45
Television	47	44	43
Landline telephone	63	48	40
Email	35	34	37
Blackberry or wireless email device	6	22	36

**Source:** Pew Internet & American Life Project Surveys.

Just how impressive is this growth? Hasn't the US experienced high growth rates among other electronic innovations? Isn't this just more of the same? Why are mobiles exceptional?

The closest US rival to the mobile phone in terms of growth and penetration is television. The first black and white televisions were introduced into the US market in the 1940s and color TV deployed through the 1960s. Today, there are approximately 235 million television sets in use in the US<sup>8</sup> compared to 263 million mobiles. This growth of television occurred over 30-40 years, while the growth of mobiles occurred in less than 20 years. Further, television is a stable product, with little growth in recent years, while mobile subscriptions continue to grow at rates over 20% per year. Television has been viewed by many as the ultimate “killer app”. No more; mobile has established its dominance in US markets. While there are more mobiles than TVs, household penetration is higher for television: 99% of households have at least one TV, while somewhat over 70% of households have at least one mobile.

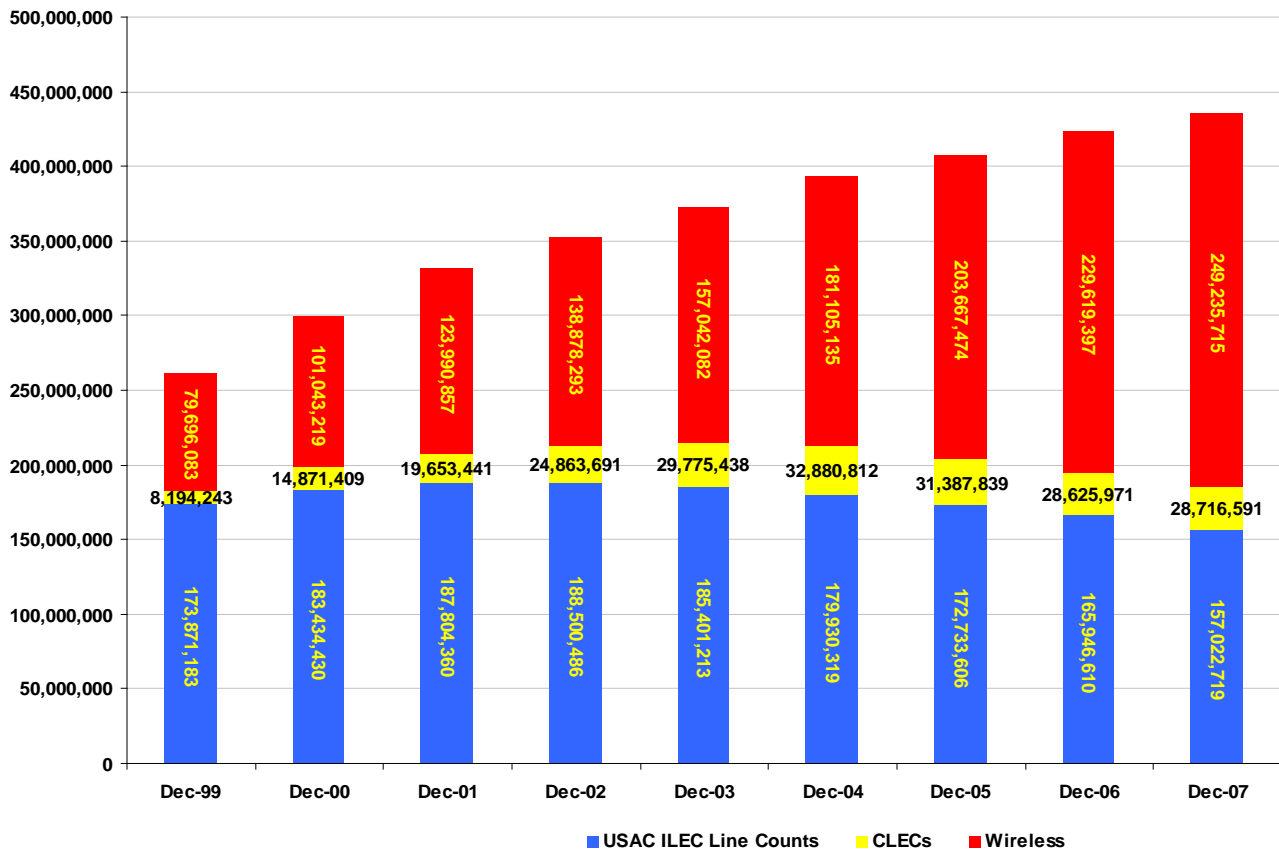
The obvious competitor to mobiles is wireline telephone. The market for wireline telephones began with the invention of the telephone in 1876 and grew to market saturation in the 1970s, when household penetration reached 94%, where it stabilized for decades. Recently, the number of telephones has been in decline. This decline includes both incumbent local exchange companies (ILECs) and competitive local exchange companies (CLECs). There are approximately 186 million wireline telephones in the US today. Recent trends in wireless vs. wireline telephony through year-end 2007 are shown in Figure 4. CLEC subscriptions peaked in 2002 and have been in decline since then. Total wireline subscriptions peaked in 2003 and have also been in decline ever

<sup>7</sup> Horrigan, John, “Mobile Access to Data and Information,” PEW INTERNET AND AMERICAN LIFE PROJECT, March, 2008, at < [http://www.pewinternet.org/pdfs/PIP\\_Mobile.Data.Access.pdf](http://www.pewinternet.org/pdfs/PIP_Mobile.Data.Access.pdf) >

<sup>8</sup> see < <http://www.csun.edu/science/health/docs/tv&health.html> >

since. As these numbers suggest, mobiles are substituting for wireline phones at an increasing rate. As of 2008, 17.5% mobile users had no wireline phone; they had chosen to become “untethered”, up from 13% in 2007. The common thread here is that mobile subscriptions continue to exhibit high growth rates, both absolutely and in cannibalizing wireline telephony.

**Figure 4**  
**US Domestic Subscription Trends: Mobile, ILEC and CLEC (through 2007)**



But surely mobile is outstripped by electronic technologies associated with the Internet, such as personal computers (PCs) and broadband (local access). The data<sup>9</sup>, however, tell a different story. In 2007, the US had approximately 73 million Internet subscribers. Also in 2007, there were 221 million Internet users; about 70% of US households were connected to the Internet, either broadband or dial-up.

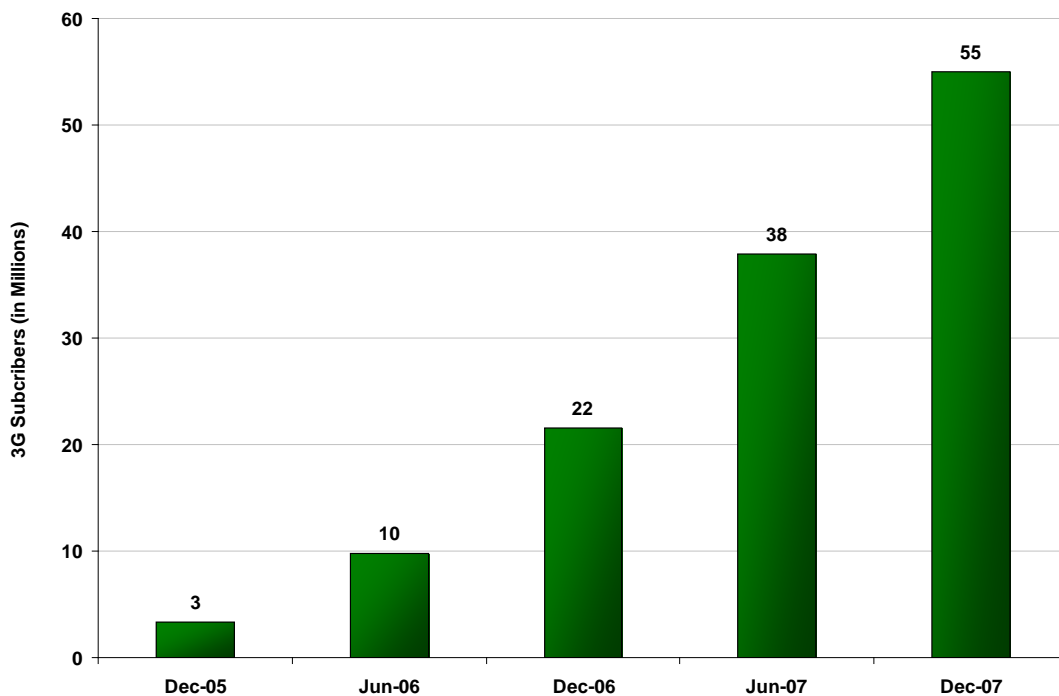
Perhaps even more surprising, mobile subscriptions exceed PC ownership in the US. In 2007, there were 220 million PCs in the US (including businesses); about 75% of US households had at least one PC. Growth in business PCs continues to increase, while household penetration appears to have stabilized.

<sup>9</sup> See Horrigan, John *op. cit.*

The results reviewed so far demonstrate the dominance of mobile over virtually all other recent technologies save the Internet. No other service or device comes anywhere close to the popularity and market acceptance of mobile, and the growth is not yet over. But this is only the initial phase of this remarkable phenomenon, in that I have focused exclusively on voice communications. Currently, the US use of data communications is growing even faster than voice communications. Applications include e-mail, web browsing, mobile twittering, texting, remote TV and wireless hot synching. The mobile is becoming the device that integrates communications and computing power to provide a variety of popular social networking applications. Key to this new development are “smart phones” and high-speed connections to the Internet. From the Blackberry phone to the iPhone and its most recent successors, customers with these powerful mobiles can tap into the power of the Internet to access all these services. Just as experience has shown that mobiles are a substitute for wireline phones, experience is also showing that mobiles are a substitute for personal computers as Internet access devices.

The growth of 3G data services in the US through 2007 is shown in Figure 5.<sup>10</sup>

**Figure 5**  
**Mobile Broadband 3G Subscriptions**



Mobile wireless broadband is a very recent phenomenon; it first appears in FCC statistics<sup>11</sup> in June, 2004 (with merely 379,536 subscribers) relative to total broadband

<sup>10</sup> See Roche, Robert, “US Wireless Metrics Review,” April, 2008, CTIA

<sup>11</sup> Data from Federal Communications Commission, “High Speed Services for Internet Access: Status as of December 31, 2007”, Jan 2009, at <[http://fjallfoss.fcc.gov/edocs\\_public/attachmatch/DOC-287962A1.pdf](http://fjallfoss.fcc.gov/edocs_public/attachmatch/DOC-287962A1.pdf)



lines of 42.5 million. By December, 2007, mobile broadband accounted for 51 million subscribers relative to total broadband lines of 121.2 million, or 42% of total broadband lines. Using the more restrictive FCC definition of broadband as 200 Kbps in both directions (“advanced service line”), mobile broadband accounted for 15.3 million lines relative to a total of 80.2 million lines, or 19% of advanced service lines.<sup>12</sup> During 2007, mobile broadband lines increased by 28.7 million (46%), or 75% of total broadband net adds in that year. Mobile firms report that data revenues have increased at 40%/year, from 0.6% of total revenues in June, 2001 to 20.3% in June, 2008.

When viewed in its entirety, the mobile phenomenon is quite unprecedented: number of subscriptions and volume of usage, voice and data, increasing applications, and growth rates that are exceptional when compared to similar products and services. Mobile has enabled Americans to talk anywhere they want, anytime. Americans can text, e-mail, web-browse, twitter, or any number of social networking tools anywhere they want, anytime. Americans have taken to this phenomenon in record numbers and at record speed. Mobile is a substitute for wireline phones, a product evidently in decline. It has recently become a substitute for wired broadband, which it is significantly outpacing in the market. For many functions, it is becoming a substitute for the PC,<sup>13</sup> and perhaps eventually the television. Most interesting, however, is that it is a complement to the Internet. On current trend, mobile may well turn out to be the most effective complement to the Internet: the ubiquitous application network connected to the ubiquitous networked device. More than the telephone, more than the PC, more than wired broadband, mobile connectivity is our likely future.

### **3. Worldwide Mobile**

While the US experience with mobile is quite unprecedented, mobile development throughout the world is even more phenomenal in its social and economic impact. The worldwide experience with mobile can be (imperfectly) divided between the OECD countries and the developing world.

In broad terms, the development of mobile in the OECD countries is similar to that in the US, only more so. Western Europe led the world in the early development of mobile, with higher penetration rates and faster deployment than the US, certainly through the late 1990s. Recently, the US and Western Europe look rather similar in their respective deployment of mobile. In East Asia, smart phones and 3G services developed much more quickly than in the West, a lead which Japan and particularly South Korea maintain

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> The numbers quoted use the FCC’s rather lax (and controversial) definition of “high speed line” as any channel capable of 200 kbps in either direction.

<sup>12</sup> Typically, mobile broadband data services such as EV-DO and WCDMA offer bandwidths around 500/800 Kbps, similar to that of “starter” DSL (384 Kbps/1 Mbps), and far less than cable or premium DSL. This discrepancy in performance may account for the differing percentages of wireless broadband of total high speed lines vs. advanced service lines.

<sup>13</sup> For a discussion of the entry of PC manufacturers into the mobile device business (following Apple’s iPhone lead), see Vance, Ashlee, “Computer Makers Prepare to Stake Bigger Claim in Phones,” *New York Times*, March 16, 2009, p. B1 at < <http://www.nytimes.com/2009/03/16/technology/16cell.html> >.

today. South Koreans enjoy mobiles with broadband speeds approaching 4G, enabling lightning-fast web browsing and even high resolution television and a variety of high speed services not available elsewhere. It is estimated that South Korea/Japan are about 12 to 18 months more advanced than the US and Western Europe; for those who fear or hope for what mobile will do to or for Americans, look to South Korea to learn what the future will likely bring.

In this paper, I focus on an entirely different set of markets: developing countries. This is not to say that developments in South Korea and Japan have been anything other than amazing; these countries might well be called “America on steroids.” But I find that the changes wrought by mobiles in the developing world are even more exceptional than in the OECD countries.

The incremental contribution of mobiles to OECD countries is mobility. These countries have already established connectivity via wireline telephones by the 1980s, which also provides data connectivity (via dial-up). Mobility is quite valuable and life-changing, as the US evidence of the previous section demonstrates. However, mobile brought basic connectivity as well as mobility to the developing world, as wireline penetration rates in these countries is very low. Prior to mobile, the only way to communicate with friends, business associates, relatives or medical personnel in rural areas was to walk to that person’s village. The isolation of rural life in India, China and Africa is beyond the understanding of those of us fortunate enough to live in OECD countries. It may also be difficult for us to understand how business can be conducted with minimal communications. Information is absolutely essential to the operation of efficient markets, and when information is not available, markets will behave poorly, leading to poverty and exploitation. Mobiles provided, for the first time, the ability for the rural poor of these countries to utilize economic information so that they could improve their own economic performance. The impact on the developing world has been quite substantial.

Mobile has had a major impact on connectivity in the developing world, as shown in Figure 6.

**Figure 6**

<b>Wireline vs. Mobile Penetration 2007<sup>14</sup></b>			
	Main Wirelines/100	Mobiles/100	Mobile/Total
OECD countries	>40	>75	
Africa	3.21	28.44	89%
India	3.37	20	86%
China	27.52	41.19	60%

The remainder of this section will present several case studies of the economic and social impact of mobiles in the developing world, which I believe is the most effective way to communicate to an audience of OECD scholars the actual impact of mobile on economic and social behavior in the developing world. I draw on an excellent series of articles in the Washington Post, which I have excerpted below.

<sup>14</sup> Data taken from International Telecommunications Union FREE STATISTICS – BY COUNTRY ICT-EYE, at < <http://www.itu.int/ITU-D/icteye/Indicators/Indicators.aspx> >.

The first demonstrates the impact of the arrival of mobile technology on the economic lives of traditional sardine fishermen on the Kerala coast of India.<sup>15</sup>

"Babu Rajan pointed off the starboard bow and shouted: "There! There!"

In choppy, gray seas four miles from shore near India's tropical southern tip, Rajan spotted the tinselly sparkle of a school of sardines. He ordered his three dozen crewmen to quickly drop their five-ton net overboard.

Within five minutes, the cellphone hanging around his neck rang. [It was] a wholesale agent calling from port, who had heard by cellphone from other skippers that Rajan had just set his nets.

Minutes later Rajan's phone rang again -- another agent at a different port.

"When I have a big catch, the phone rings 60 or 70 times before I get to port," he said.

The cellphone is bringing new economic clout, profit and productivity to Rajan and millions of other poor laborers in India, the world's fastest-growing cellphone market.

That explosive growth has meant greater access to markets, more information about prices and new customers for tens of millions of Indian farmers and fishermen. The cellphone is putting cash in the pockets of people for whom a dollar is a good day's wage. And it has made market-savvy entrepreneurs out of shepherders, rickshaw drivers and [fishermen].

Rajan said that before he got his first cellphone a few years ago, he used to arrive at port with a load of fish and hope for the best. The wholesaler on the dock knew that Rajan's un-iced catch wouldn't last long in the fiery Indian sun. So, Rajan said, he was forced to take whatever price was offered -- without having any idea whether dealers in the next port were offering twice as much.

Now he calls several ports while he's still at sea to find the best prices, playing the dealers against one another to drive up the price.

Rajan's phone rang a half-dozen times in a half-hour, with calls from dealers in different ports, buyers and other boat captains. Rajan talked quickly and kept hauling. Rajan agreed to [a] deal [with a wholesale agent at his home port]. [H]e said the dealer was forced to offer a decent price, knowing that Rajan could still go elsewhere. As insurance, Rajan returned the call of the other dealer who had called him, just to keep good relations for another day.

Rajan said that without his phone, his catch might have gone to waste. Because he called ahead to the port, buyers there knew that he was coming, what kind of fish he had and the size of his catch. In the past, Rajan said, he would sometimes arrive at port late in the day only to find that all the buyers had gone home, unaware that another boat was coming. His catch would go unsold, and he and his crew would go unpaid."

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<sup>15</sup> Sullivan, Kevin, "For India's Traditional Fishermen, Cellphones Deliver a Sea Change," WASHINGTON POST, Oct 15, 2006, p. A01 at < <http://www.washingtonpost.com/wp-dyn/content/article/2006/10/14/AR2006101400342.html> >.

This particular case was studied extensively in Jensen;<sup>16</sup> as stated in his abstract:

"Between 1997 and 2001, mobile phone service was introduced throughout Kerala, a state in India with a large fishing industry. Using microlevel survey data, we show that the adoption of mobile phones by fishermen and wholesalers was associated with a dramatic reduction in price dispersion, the complete elimination of waste, and near-perfect adherence to the Law of One Price. Both consumer and producer welfare increased."

The broader picture of mobiles in India is depicted in "M-Powering India: Mobile Communications for Inclusive Growth."<sup>17</sup> This report notes that by the end of 2007, India had replaced the US as the second largest mobile market (in terms of subscribers) in the world (after China) and is heading for ½ billion mobile subscriptions by 2010. The report also noted the importance of "m-banking" (discussed below), recommending a standard m-currency to facilitate greater "m-commerce."

It is no surprise to economists that information is the key to efficient markets, and that if mobiles increase the information available to market participants, the performance of markets will improve and incomes will rise. Jensen's careful empirical study of this market documents the gains from increased information due to mobile availability.

If mobiles can improve the efficiency of fisheries markets, one might expect they can improve retail financial markets, that most information-intensive of all markets, even more. In fact, much of the developing world is significantly under-banked at the retail level, and mobile operators are finding a profitable niche in facilitating payments and transfers, both domestically and internationally. Referred to as "m-banking", it appears to have arisen in developing countries where retail banking is unavailable or unreasonably expensive. The following case study<sup>18</sup> of m-banking in the Philippines (and the UK) demonstrates the power of mobiles to facilitate cash transfers and, again, improve the efficiency of markets.

"It was 10:33 p.m. when Dulce Amor Bandy's cellphone beeped with her favorite kind of message.

"You have received 1,321.00 of G-Cash," read the text on her phone's glowing screen.

That meant her uncle in London had just deposited 1,321 Philippine pesos -- about \$26 -- into her Globe Telecom cellphone account, which Bandy uses like a bank. "My phone is now my wallet," said Bandy, 29, a cheerful woman with a sparkling smile.

The cellphone-based system that conveys cash between Bandy and her uncle has the potential to revolutionize the way hundreds of billions of dollars are moved around the

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<sup>16</sup> Jensen, Robert 2007, "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector," *QUARTERLY JOURNAL OF ECONOMICS*, CXXII (3), August, pp. 879-924.

<sup>17</sup> Adler, Richard and Mahesh Uppal, "M-Powering India: Mobile Communications for Inclusive Growth." Aspen Institute India, 2008, at <  
<http://www.aspeninstitute.org/sites/default/files/content/docs/communications%20and%20society%20program/2008INDIA.PDF> >.

<sup>18</sup> Jordan, Mary, "New Conductors Speed the Global Flow of Money," *WASHINGTON POST*, Oct 3, 2006, p. A01 at <  
<http://www.washingtonpost.com/wp-dyn/content/article/2006/10/02/AR2006100201462.html> >

world, according to experts who study global cash flows. But traditional methods of moving money in small, personal amounts can be slow and costly...

Eugene Bandoy, 50, is a Filipino architect who lives in London and helps other expatriates buy property back home. When potential buyers want to take a look at condominiums or houses in the Philippines, his niece shows them around...

Last month, Bandoy needed his niece to go to Quezon City, just outside Manila, to show a condominium to a woman who works in London but was home on vacation and interested in buying. But Dulce, like so many people struggling to get by in this country of almost 90 million people, said she didn't have the \$1 for a bus or train ride to meet the client. She called her uncle and told him, "I need money or I can't meet her."...

[In London, the agent] typed in the amount he was sending and the day's exchange rate for the British pound and Philippine peso. Then she hit the "send" button to move the order to the phone company. Seconds later, a message appeared on her screen, confirming the transfer.

It was 3:32 in the afternoon in London -- 10:32 p.m. in Manila. At 10:33 p.m., [Dulce's] phone, sitting on her bedside table, pinged with the much-anticipated message.

[Next day, Dulce] walked into the glitzy Globe phone store, where customers can browse the flashiest new phone models and pick up G-cash, as the company calls money transferred via phone...Less than five minutes after arriving at the store and after paying 26 cents -- a 1 percent fee -- she walked out with about \$24 worth of Philippine pesos. By 10:30 a.m., she was walking a potential buyer through new condominiums in a middle-class area of Quezon City. "She loved it! She signed the contract!" Bandoy recalled later."

M-banking is making an appearance throughout the developing world, where costly retail banking creates an opportunity for mobile operators to fill a need for customers, improving not only their ability to do business, but improving their lives as well. As previously mentioned,<sup>19</sup> India is focusing on facilitating m-commerce with plans for a standard m-currency, and m-banking spreading in sub-Saharan Africa, where the reach of traditional banks is quite limited.

But the social impact of mobiles is not limited to m-commerce. For example, text messaging has become a popular tool for political organizers around the world. To quote from a recent news article:<sup>20</sup>

"Cellphones and text messaging are changing the way political mobilizations are conducted around the world. From Manila to Riyadh and Kathmandu protests once publicized on coffeehouse bulletin boards are now organized entirely through text-messaging networks that can reach vast numbers of people in a matter of minutes.

The Philippines, widely called the text-messaging center of the world, has led the way. When President Joseph Estrada was forced from office in 2001, he bitterly complained that the popular uprising against him was a 'coup de text.'"

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<sup>19</sup> Aspen Institute India, *op. cit.*

<sup>20</sup> Jordan, Mary, "Going Mobile: Text Messages Guide Filipino Protesters," Washington Post, August 25, 2006, p. A01, at < <http://www.washingtonpost.com/wp-dyn/content/article/2006/08/24/AR2006082401379.html> >.

Perhaps most heartening is the applications of mobile to medical care in developing countries. Since the dawn of the Internet, and especially since the advent of broadband, “telemedicine” has been hailed in the US as a beneficial application of the technology. Unfortunately, there are virtually no known applications actually in place in the US. But as it turns out, we have been looking in the wrong place and the wrong application. In fact, telemedicine is alive and well in Africa, and the enabling technology is mobile, as illustrated in this case study:<sup>21</sup>

“Medical records and other health information can now be easily shared via mobile phones and other modern communications technologies.

The small, dusty village of Mayange lies 20 kilometres from Rwanda's capital, Kigali. Its health centre has fewer than 40 beds but serves an estimated 35,000 people. The Mayange centre could well be like thousands of other health facilities across the continent struggling to meet patients' needs with very few resources and staff.

But thanks to an innovative partnership involving the government, non-governmental organizations and private companies, the Mayange centre is now able to use mobile telephones to provide better treatment. With software developed by Ericsson and phones donated by the Rwandan subsidiary of Mobile Telephone Networks (MTN), a South African firm, health workers can call up the medical records of pregnant women from an online database and then, by cell phone, tell care-givers what to do. The Mayange clinic is not alone in using mobile networks to improve health care. Across Rwanda, 143 public and private health centres that offer anti-retroviral medicines (ARVs) to people with HIV/AIDS now use Tracnet, a system that employs mobile phones to collect information on patients' infections. It helps the national drug centre keep track of which medicines are available in each health centre and when to resupply, making shortages of ARVs less common during an emergency. The memory of each phone donated by MTN includes a maternal and child-care training manual, with images and audio directions that can be sent to mothers and families.

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This is not telemedicine as envisioned by advocates in the US; but it is telemedicine in countries and markets where the need is perhaps far greater and the impact far more substantial. This case study, and the other case studies of this section, highlight (i) how profound is the impact of mobiles in the developing world; (ii) how ingenious are the people of the developing world in devising applications that meet their needs without fancy “smart phones;” and (iii) how little we in the developed world understand the needs and solutions of the developing world. Each of these case studies was a surprise to me, and yet in retrospect why should I have been surprised?

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<sup>21</sup> Kimani, Mary, “Rwanda: Better Health at the Click of a Button,” AFRICA RENEWAL (UN), May 9,2008, at < <http://allafrica.com/stories/200805091090.html> >.



There is some empirical evidence that greater deployment of mobile leads to higher economic growth rates, and that this impact is twice as great for developing countries as for developed countries. Waverman, Meschi and Fuss<sup>22</sup> estimate an endogenous growth model using World Bank data and find that for low income countries, an additional penetration rate of 10 mobiles per 100 population may raise GDP growth by ½%/year. For high income countries, an additional penetration rate of 10 per 1000 may raise GDP growth by ¼%/year.

This, of course, is only one study, in an area notoriously difficult to obtain reliable empirical estimates (i.e., estimating the impact of infrastructure on economic growth). The estimates appear quite large; an impact of ½ % on GDP growth has a very substantial cumulative effect on the income of a nation's people. It is perhaps sufficient to justify the statement by development economist Jeffrey Sachs: "The cell phone is single most transformative technology for development."<sup>23</sup>

This paper has included an array of numbers, the purpose of which is to demonstrate how dominant mobile has become in the lives of everyone on earth. The reader will judge whether or not I have made the case. There is a single pair of numbers, however, which I believe best sums up the extraordinary growth, penetration and impact of mobile: there are currently 4.1 *billion* active mobile subscriptions worldwide, compared to a world population of 5.7 billion, a penetration rate of 61%. This is more than personal computers, more than wireline telephones, more than Internet users, even more than television; a lot more.

#### 4. Limits to Growth

Perhaps the most surprising aspect of mobile is that growth in both voice and data continues to be high, even though penetration levels are greater than any other technology. In the US, mobile subscriptions are growing at over 25% while data services are growing at over 40%. In developing countries such as India, growth in mobile subscriptions has been 42% since 2002.

Can these high growth rates be sustained? I parse this problem into three parts: (i) growth in number of persons with mobiles; (ii) growth in number of subscriptions per person; and (iii) growth in data services.

**Growth in Persons with Mobiles** In OECD countries, the fraction of persons with mobile is high and at some point growth must level off; this fraction obviously cannot

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<sup>22</sup> Waverman, Leonard, Meschi, Meloria and Fuss, Melvin, "The Impact of Telecoms on Economic Growth in Developing Countries," VODAFONE POLICY PAPER SERIES, 3, March, 2005 at <  
[http://www.vodafone.com/etc/medialib/attachments/cr\\_downloads.Par.78351.File.dat/GPP\\_SIM\\_paper\\_3.pdf](http://www.vodafone.com/etc/medialib/attachments/cr_downloads.Par.78351.File.dat/GPP_SIM_paper_3.pdf)>.

<sup>23</sup> Quoted by Ewing, Jack, in "Upwardly Mobile in Africa," BUSINESS WEEK, Sept 13, 2007, at <  
[http://www.businessweek.com/globalbiz/content/sep2007/gb20070913\\_705733.htm?chan=globalbiz\\_europe+index+page\\_top+stories](http://www.businessweek.com/globalbiz/content/sep2007/gb20070913_705733.htm?chan=globalbiz_europe+index+page_top+stories)>.

exceed 100%. In the developed world, however, penetration rates are approximately 20% and there is much room for future growth. While there are currently 4.1 billion mobiles in the world today, there may well be another billion or so that may be added.<sup>24</sup> Eventually, everyone who wants a phone will have one, and growth will level off.

In order to achieve this level of penetration, there are four key factors. The first is price. The fastest growing developing country is India, which also has the lowest prices for both mobile devices and minutes of use. The ability of mobile operators to bring devices to the very poor is crucial to capturing the next billion customers, and this depends upon the development of very low cost mobile technology. Market evolution thus far has shown that there is a market at the low end of the income distribution, but further effort will be needed to capture even more.

The second key factor is the availability of spectrum. Use of the electromagnetic spectrum is the very lifeblood of mobile communications. In most countries, spectrum is completely controlled by the government (in many cases, the military) and is released to the private sector by bureaucratic processes. In some countries, spectrum has been allocated via auctions, but the auctions and the terms and conditions of release are still subject to bureaucratic processes. In countries that use auctions to allocate spectrum, the relatively high prices received by the auctioning agency suggests that spectrum is tightly constrained relative to market demand. Using governments rather than markets to allocate scarce spectrum has been a recipe to keep spectrum scarce --- for bureaucratic rather than technical reasons.<sup>25</sup> Improving the allocation of spectrum is a key factor to maintaining mobile growth rates, especially to underserved low income areas.<sup>26</sup>

The third key factor is “light touch” regulation. Wireline telephony has traditionally been subject to very substantial price-cost-entry regulation, whereas wireless telephony has been subject to very little regulation (other than spectrum allocation). The growth and nimbleness of mobile compared to wireline is striking. For example, wireline telephone rate structures are determined in regulatory proceedings (“Title II” regulation in the US) and are typically distance and time sensitive. Wireless telephone rate structures are determined in a market setting, free of regulatory oversight. Mobile rates in the US are typically not distance or time sensitive, and within broad buckets, not even volume sensitive, a rate structure which customers and operators seem to prefer. As a result, wireline firms have been migrating to this rate structure as the market, not regulators, has revealed the structure most suitable for the business. The freedom from oppressive regulation has also led to technological innovation in mobile far more rapid than ever

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<sup>24</sup> 4.1 billion mobiles does not, of course, mean that 4.1 persons have mobiles. It is quite common in some countries for some persons to own multiple mobiles, or multiple SIM cards.

<sup>25</sup> See, for example, Faulhaber, Gerald, “The Future of Wireless Communications: Spectrum as a Critical Resource,” *INFORMATION AND ECONOMIC POLICY*, 18, pp. 256-271, 2006 at <  
[http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6V8J-4KGG1HN-1&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=f470bd87fb651a47de8f418f2a6de0c1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V8J-4KGG1HN-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=f470bd87fb651a47de8f418f2a6de0c1) >

<sup>26</sup> For a discussion of problems in India with government release of spectrum, see “The Hesitant Auctioneer,” *THE ECONOMIST*, Feb 26, 2009, at <  
[http://www.economist.com/business/displaystory.cfm?story\\_id=13185039](http://www.economist.com/business/displaystory.cfm?story_id=13185039) >



occurred in wireline, and significantly more competitive entry, and successful entry, than has ever occurred in wireline. Maintaining this light touch regulation is essential realizing the customer benefits of mobile worldwide.

The fourth key factor which applies to poor rural areas is the availability of reasonably reliable power. Without the ability to charge batteries, mobiles become useless. There are, of course, alternatives to centrally distributed power. Rural customers often use solar power<sup>27</sup> or even wind power to run simple appliances and charge their mobiles. But lack of central power to poor rural areas is likely to hinder mobile deployment.

**Growth in Subscriptions per Person** Quite a few OECD countries have achieved penetration rates substantially above 100%, suggesting that many, perhaps most, customers carry more than one phone or at least more than one SIM card. Should countries such as the US follow this lead and increase penetration levels from 61% to 120%, this could lead to substantial growth. The likelihood of this growth is questionable; Kalba<sup>28</sup> speculates that the drivers of supra-100% penetration rates are, among other things, the development of the prepaid market. It is unclear whether these factors will apply in countries like the US. It is also unclear if increasing subscriptions per person will increase usage. The US has much higher usage per phone than does Europe, yet penetration in the US is much lower than in Europe. Presumably, the value of a mobile comes from actually using it; if a single individual were to split her usage among various mobile devices, rather than use just one, it is not clear that this would increase aggregate social value at all.

**Growth in Data Services** The phenomenal growth of mobile data services in the OECD countries demonstrates that there is much additional room for growth along this margin, and there is no natural limit to such growth. Early data services such as e-mail and texting show rapid growth, even as newer, higher bandwidth services such as TV, two-way video and high-speed access to the World Wide Web are emerging in leading countries such as Korea and Japan. In these countries, mobile is evolving to a converged platform, offering voice, data communications, Internet access, and access to video content and this convergent has no natural limits in terms of extent and intensity of use by customers. Data services is the most likely margin along with sustained growth will occur. Even in the developing world, it is clear that data services are very highly valued, as shown in the m-banking case study of the previous section. On the supply side, this will require bringing 3G services to the developing world and 4G services to the OECD countries.

There are three key factors that will determine whether the data services margin can maintain a high growth rate in the future. The first key factor is demand; will customers in OECD countries and in the developing world really want zippy new Internet and video services, and will they be willing to pay for them? Our best guide to what the future might bring is to look to the immediate past; Figure 7 shows recent trends in wireless broadband access in the developed and the developing world compared to that of wireline

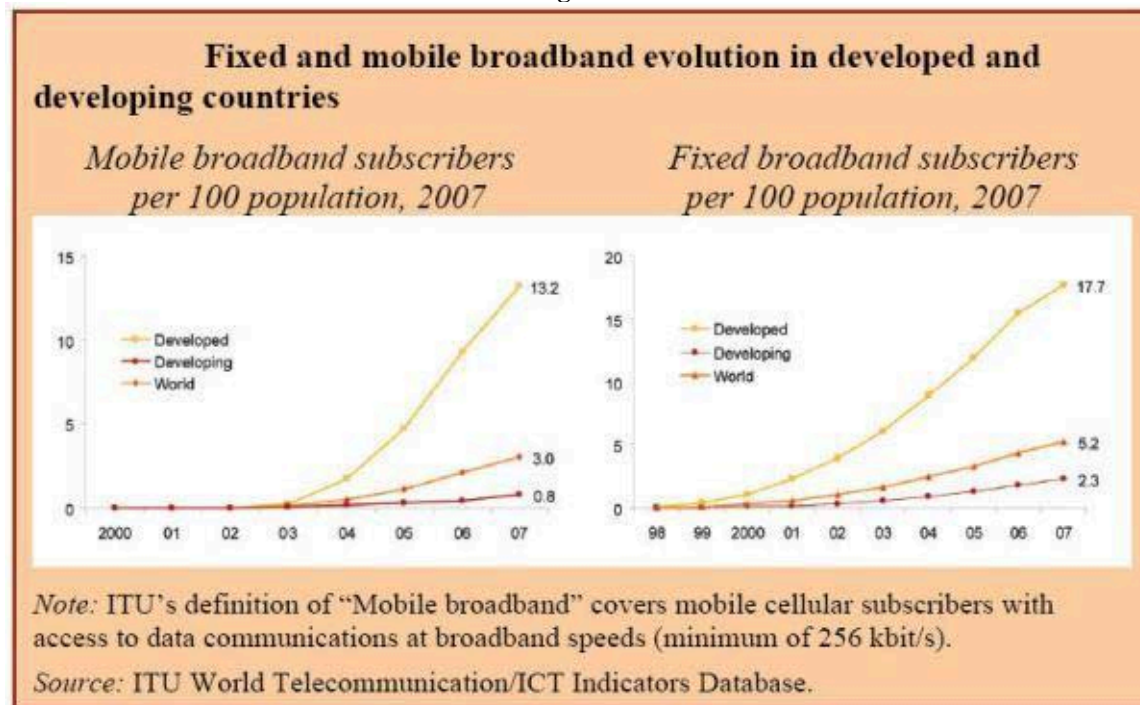
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<sup>27</sup> See Ewing, Jack *op.cit.*

<sup>28</sup> Kalba, Kas *op cit.*

broadband, and demand appears to be growing very rapidly worldwide. It would seem unlikely that this demand growth is likely to terminate in the near future.

Figure 7



Evidence from the most advanced countries of Korea and Japan suggest that the rest of the world can look forward to a mobile environment of much more intense data communications, including two-way video and other bandwidth-intensive applications in the near future. Betting against continued growth in data services is not likely wise.

There are three key factors required to maintain high growth on the data services margin. The first factor is the availability of spectrum. Broadband 3G and especially 4G services require very substantial bandwidth, all of which is carried via the electromagnetic spectrum. 4G services may well require 40-100 GB bandwidth which requires vastly more spectrum than government bureaucracies have trickled out to the market. Bringing enough spectrum to market requires more than increased government largesse. It requires a new spectrum regime, moving away from command and control. Solving the spectrum allocation problem is a priority for opening up mobile data services to fulfill their potential.

The second factor is technical innovation in mobile devices that permit them to fully converge with computing and television. Currently, mobile devices are constrained in their ability to compete effectively with computers and televisions. Mobile screens are quite small and keyboards are small as well, relative to the full-sized versions of both associated with their fixed counterparts. And yet we observe many customers texting and twittering away, thumbs flying across tiny keyboards. And we observe many customers watching television, including sports, on their mobiles. Even with the very limited input

and output channels of mobile devices, we see the demand is there. But not everyone will have flying thumbs. There are two avenues to overcome these limitations: (i) allow mobile handsets to communicate over short ranges with more capable display and input devices; using high-bandwidth WiFi so that a mobile handset can stream video it receives online to a high-definition TV is an obvious application that is well within the capabilities of commercially available technologies. (ii) Use projection technologies to enable the device itself to improve both display and keyboard. Technology is available today which permits a mobile device to project its screen on a wall or other surface at WVGA resolution,<sup>29</sup> sufficient for several people to simultaneously watch a movie or TV program. Also, technology is available today which permits a mobile device to project a keyboard image on a surface and detect which “keys” a customer’s fingers are striking on the keyboard image, translating this information into a keystroke stream.<sup>30</sup> These technologies are certainly not for everyone. But they can enable mobiles to overcome the display and keyboard limitations that could hinder growth of mobile data services.

The third key factor is continued “light touch” regulation, as mentioned previously. In order to encourage the rapid evolution of technology, it is essential that governments step way back from this dynamic industry and let it evolve as customer demand evolves.

## 5. Conclusion

Far from being one of the annoyances of modern life, mobile technology has become one of the defining features of our lives. Not only has its influence affected more Americans than any other electronic technology, it has an even greater influence on the lives of customers in the developing world in a positive way. It is now the dominant electronic technology, and its growth looks likely to continue.

To ensure that mobile fulfills its rich promise, I identify four key items:

- Release large amounts of spectrum for use by those offering mobile services; this is unlikely to happen under current processes for allocating spectrum.
- Encourage more technological innovation in two directions:
  - Reduce the cost of low-end devices and systems so that the world’s poor can afford to be connected.
  - Increase the ability of mobiles to be the converged technology for communication, computing and television by extending mobile’s input and output capabilities.
- Maintain “light touch” regulation, so that market forces for deployment and innovation have maximum play consistent with the public interest.
- For poor rural areas, encourage the deployment of power delivery systems so customers can charge their mobiles (among many other things).

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<sup>29</sup> Comer, Stuart, “Big Screen Projection from Your Cellphone,” ITWIRE, March 31, 2008, at < <http://www.itwire.com/content/view/17386/127/> >. Several firms have prototype mobile phone display units.

<sup>30</sup> A projection keyboard is available on Beagle Board.