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The Next Decade of ICT Development:

Access, Applications and the Forces of Convergence

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The last decade has seen an incredible expansion in access to ICTs, as well as an explosion in applications. Driving this revolution have been new disruptive technologies exploited by new business models, in turn enabled by policy and regulatory reforms. The technologies driving change in the next decade may well encourage a further blurring of the line between access, industries and applications, leading to new challenges for the sustainability of existing business models and policy and regulatory environments going forward.

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The spread to ubiquity of the telephone has been both rapid and widespread. More than half of the world's households now have access to a fixed telephone; there are in the region of two billion mobile subscribers; and the mobile footprint now covers as much as 77 percent of the World's population. The growth in access was particularly phenomenal in Sub-Saharan Africa where fixed and mobile teledensity expanded from about one telephone per 100 people in 1990 to more than eight in 2005.

The mobile revolution has also had a dramatic impact on access in rural areas. In Burkina Faso, there were fewer than 7,000 telephones outside the capital city in 1990, serving a population of 8.3 million people spread over 100,000 square miles. Today, the mobile footprint covers more than 50 percent of the population, living outside of Ouagadougou.

It is worth noting how much developing countries have led the way in the mobile revolution, not least demonstrated by the fact that China is by far the world's largest mobile market and that there are considerably more mobile subscribers in the developing than the industrial world. Very simple data applications over mobile phones have also spread rapidly in developing countries. Perhaps five hundred billion SMS text messages were sent worldwide in 2004,[ii] with some developing countries leading growth in SMS usage. For instance, the average Philipino mobile subscriber sends ten text messages a day, accounting for nearly 55 billion messages each year.[iii]

Developing countries are even beginning to catch up in terms of more advanced use of information infrastructure. The number of Internet users in developing countries increased from about one per thousand people in 1993 to 75 per thousand in 2003. However, there remain significant gaps. Internet bandwidth per million people is 4 Mbps in low-income countries compared to 3,657 Mbps in high income countries, whilst broadband prices are 53 times as high. The number of secure servers in low and middle-income doubled between 2001 and 2004, reaching above 10,000, but this still left the developing world's share of secure servers at about three percent of the global total. This suggests a broader issue with the adoption of advanced Internet applications in poor countries, a topic we will return to.

Both because of great demand and continued access gaps, going forward, developing countries may invest as much as USD100 billion in rollout each year. Pyramid Research estimates that over 80 percent of new subscribers added to global mobile networks will be in Africa, the Middle East, Asia and Eastern Europe over the 2004-2009 period. As a result, it is quite likely that developing countries will be setting trends in applications, revenue models and cost saving approaches. This will be especially the case for mobile networks, which will provide an important platform for companies to reach the "fortune at the bottom of the pyramid."

Driving this revolution, new technologies have been exploited by new business models, and in turn enabled by policy and regulatory reforms.

The last forty years have seen steadily declining costs of computing power. From 1959 to 2000, the GDP price deflator rose 3.9 percent per year, while computer prices fell 19.3 percent per year.[iv] This decline continued into the new century. Suppliers are beginning to discuss retail prices of USD100 for laptops and USD30 for cellular phones. As a sign of how rapidly computing costs have fallen, USD100 wouldn't buy you ten minutes of the requisite electricity to power the world's first electronic computer, ENIAC.[v]

Similarly, the costs of information infrastructure have dropped. Fixed line switching costs have fallen 50 percent over the past decade, and are likely to fall considerably further in the next decade, even as DSL and related technologies increase the capacity of the last mile. Advances in fiber optic technology underlie the massive carrying capacity of backbone networks, like the 320 Gbps available between London and New York.[vi]

The costs of mobile networks have also fallen considerably. Dropping costs allow mobile operators in many developing countries to make profits with monthly average revenues per user (ARPU) below USD10 compared to USD30 or USD40 for fixed operators.[vii] Spectrum-based operations are also much more easily scaleable, both in terms of responding to low customer density but also in terms of quality of service. Costs to put in fixed telephone are not much less than fixed cable broadband, while cellular systems allow easier expansion as demand picks up.

Considerable rollout of services by private mobile operators has been the significant factor behind dramatic increases in sector investment. Between 1992 and 2002, annual investment in telecommunications infrastructure in the developing world increased from around USD25 billion to around USD65 billion, with investment as a percentage of GDP more than double the rate in developing than developed countries by the end of the decade.

Private investment in the sector in developing countries grew from under USD10 billion a year at the start of the decade to reach above USD50 billion in 1998, falling back somewhat to around USD30 billion in the new century.

Private operators in developing countries have used innovative business models to extend profitable access to low-income users. By 2003, there were more prepaid than postpaid mobile subscribers worldwide, again with the developing world leading the way. Africa was the region with the largest percentage of prepaid customers, accounting for nearly 90 percent of subscribers.[viii] Other innovative business models in the developing world included Grameen Phone's combination of microfinance to support the purchase of mobile phones by women in villages who repaid their loans by selling airtime; Mexico's Unefon, which rents mobile phones; and Spice Telecom in India that actively recruited entrepreneurs to operate phone shops.

Supporting the rollout of new technologies and innovative business models was the rapid evolution of sector policy. From a position of government-owned monopoly provision, there has been a worldwide move towards competitive private provision under independent regulation. Ninety percent of the world's population lives in countries with competition in mobile provision, although the figures drop to 78 percent for fixed local and 60 percent for international services. In particular, assignment of radio spectrum frequencies has increasingly been based on auction or other comparatively transparent, fair and economically efficient methods.[ix]

It is clear that policies and regulations that support private, competitive provision have been a key to the revolution in information infrastructure access. Developing countries with competitive sectors saw approximately 50 percent higher private investment between 1998-2002, 20 percent lower mobile call and access pricing, and far more rapid rollout of services as a result.[x]

What will be the technologies driving change in the next decade?

Convergence and spectrum capacity growth are at least two technological forces that are already remaking the sector. Earlier this year, Microsoft chairman Bill Gates discussed the concept of kitchen-based video screens showing personalized information as well as TV and Internet news, all linked wirelessly to mobile phones and office computers as part of a "connected future." Meanwhile, Apple reported sales of 6,451,000 iPods for the 4th quarter of 2005, and the majority of those sales will have involved machines with the capacity to play video downloaded from the Internet, as well as store addresses and names, pictures and of course music. Mobile handsets that can receive streaming video have been launched in the last year. These are signs that the long heralded force of convergence is rapidly gaining strength.

The conversion of all information carried over networks to digital signals allows for competitive provision of services by previously distinct networks: cable companies providing Internet services; Internet service by telecoms providers; and so on. One manifestation of this element of convergence is that 2005 saw approximately seventy billion minutes of international voice traffic carried by VoIP, more than a doubling from the year before[xi] with an additional 685 billion minutes of local and national calls made by VoIP.[xii]

In 2004, VoIP accounted for more than 14 percent of all international traffic, and again, this is an area where developing countries are in the forefront of change. About half of inbound international calling minutes to Mexico, Brazil and Bangladesh are VoIP.

Whilst the quantity of voice and data transferred over networks is growing, the capacity of the spectrum to carry information is also exploding. Over time, technology has evolved in ways that make it possible to build much more efficient and dynamically-responsive (intelligent) radio systems that can allow many users and uses to simultaneously share the same frequency bands. Technologies like smart antennas, spread spectrum modulation, and cognitive (software) radios are making it feasible for transceivers to dynamically change their frequency, modulation, or power levels to enable more efficient and intelligent spectrum sharing. As a group, these technologies enable users not to cause insurmountable interference to each other even when transmitting at the same time, in the same place, and on the same parts of the spectrum. Combined with technologies such as 3G and WiMax, they have the potential to significantly increase the capacity of the spectrum to support wireless broadband.

All of this suggests a further blurring of the line between access and applications, and a number of challenges for business models…

The days when telecommunications companies sold one product (voice communication) using one technology (fixed copper) are long over. But change to date is likely to be dwarfed by changes in the future, when infrastructure may become a small part of a much broader package, potentially invisible to many end users. Some further evidence for this is the recent decision of satellite television provider DirecTV to move into broadband and voice provision, following cable operators that have done the same. Developing country companies are also exploring the 'triple play' of voice, data and video, including Senegal's Sonatel, which has created Sonatel Multimedia to look at the provision of VoIP and IP-TV over their networks.

For developing countries, cheap, simple mobile devices (such as the GSMA's Emerging Market Low Cost Handset) will remain core to extending access to poor people. The number of applications available over those devices is likely to expand and, if the last few years are any guide, it may be that developing countries will again lead the way in this continuing revolution. For example, the Philippines already has over 3.5 million m-commerce users, driven by the ability to transfer both cash and airtime between customers, with transfers allowed for amounts as low as four cents. Safaricom in Kenya and GLOBE telecom in the Philippines are both experimenting with microfinance via mobile which will allow loan advances and repayments over the phone, providing access to financial services to many of those that lack them. A similar network is being developed in South Africa. M-commerce systems cost as little as USD5 million to set up, suggesting that networks as small as 25,000 users could profitably support commerce over mobile phones.[xiii]

Developing countries are leading the way in profitable provision at low ARPUs. We have noted that monthly mobile ARPUs in many developing countries are considerably below USD20. In India it is around USD10. Add together the ARPU of mobile, fixed, pay TV and Internet in India you get USD33, compared to a similar figure in the US of USD143.[xiv]

Nonetheless, the 'triple play' may be particularly important to developing country operators to preserve ARPUs and reduce churn. Combined with the potential for spectrum to be less of a scarce resource and continuing improvements in the capacity-to-cost ratio for information infrastructure, convergence may leave infrastructure as largely a wholesale business supporting retail applications providers exploiting the 'triple play'.

The continuing reduction in the price of rolling out network coverage along with technological advances allowing, for example, the transmission of signals over electricity wires is likely to lead to ever-expanding wholesale infrastructure competition, even in less attractive areas in developing countries. Alternate telecommunications networks are one early sign of such growing competition. For example, India's Railways (RailTel), Gas Association of India Ltd (GAILTel), and the national electricity distribution network— PowerGrid—have each built their own trunk line telecommunications systems. These alternate networks continue to build spatially extensive trunk networks which, by 2008, will see railways with 40,000 kilometers of Optical Fiber Cable (OFC), power distribution with 20,000 kilometers and gas distribution with 17,000 kilometers.[xv]

Parts of the telecommunications industry are already extremely competitive. In a number of industrial and developing countries with open competition, levels of concentration in market share of international communications are similar to those for the chocolate industry.[xvi] At the same time, it is possible that we will see consolidation in parts of the wholesale industry, with one or only a few wholesale providers selling capacity to multiple operators, on the model of Virgin and Wal-Mart piggybacking on T-mobile's infrastructure in the UK and Germany, respectively.

…Policy models will also have to adjust, covering taxation…

It is worth noting that the continuing decline in the costs of providing service under the combined pressure of competition and technology change increase the influence of taxation in determining who can afford access to infrastructure and who cannot. As a result of the sector's rapid expansion and the image of telecommunications as a luxury good, it has become an increasingly important source of general corporate tax and special additional tax revenues. Nineteen of the 50 countries surveyed in the recent GSMA study levy additional taxes on mobile phone users, over and above the standard sales taxes. Some of these additional taxes are telecom specific, such as service activation taxes. These special taxes average USD13 per annum per subscriber.

Any undifferentiated special tax on telecoms may well turn out to be highly regressive. In Chile, the poorest twenty percent of the population spend about 3.5 percent of their income on telecommunication services, compared to about 2.5 percent for the richest quintile of the population, for example. Poor people with access will pay a larger percentage of their income on these special taxes than rich people, and many poor people will be denied access at all by the additional cost barrier put in place by the tax.

Creative taxation policies covering special taxes on infrastructure, handsets and terminals and service might allow for differentiation to ensure rollout and a progressive impact. Perhaps expensive, new handsets could be taxed at a higher rate than cheaper, older models.

Lower taxes on wholesalers who resell time to village phone operators or on providers rolling out access to previously unserved areas might be appropriate.

…regulation…

As a result of convergence, separate institutions to cover Internet, broadcast and other media content will face cases that overlap. For example, South Korea's 1995 Electronic Communication Business Law established a separate Information and Communication Ethics Office with broad powers to censor Internet content. If the content being provided is a podcast of a television show previously shown on free to air television, it is not clear who should regulate this content, or why it should go through an additional regulatory hoop.

One response to the process of convergence has been the creation of 'converged' regulators covering both telecommunications and media more broadly. The United States' FCC heads in this direction, covering telecoms and broadcast media. As the FCC has responsibility covering all electronic communication, it has theoretical regulatory responsibility over Internet content as well, although the nature of legal institutions in the country mean that the limited cases of content control (governing pornography, for example) are enforced by the legal system and law enforcement agencies. The United Kingdom's Ofcom and South Africa's Icasa are other examples where Internet regulation falls under the same institution as broadcast regulation.

Regarding the activities of these new regulators, it is a developing good practice that licenses are issued for services and spectrum wavelengths rather than technologies. If the sector moves further towards a model of network wholesalers supporting numerous competing retail service providers, movement towards universal, technology-neutral licensing will make ever greater sense. The model will also provide new challenges for regulators working in an IP-centric world where multiple small retail ICT players with innovative approaches need reasonable and fair interconnect to the backbone.

Reform of spectrum allocation procedures will become increasingly important in developing countries, and may prove more straightforward if regulation of the entire spectrum falls under one body. By one estimate, about one-half of the total value of the spectrum is wasted on uneconomic uses in the United States today. Auctions account for only about two percent of all spectrum assignments, and spectrum allocation for unlicensed use using the new technologies that allow shared access is limited.[xvii] Improving spectrum administration would yield significant benefits, but governments may wish to consider moving straight into property rights or commons approaches. New Zealand, Guatemala, United Kingdom, and United States all experimenting with spectrum trading. Developing countries at an early stage of building up spectrum management capacity may benefit from adopting new solutions from the start. These may be especially well suited for low and middle-income countries.[xviii] Developing countries also can become fertile testing grounds in the early stages of commercial deployment.

…and the broader business environment.

Assuming the sector policy barrier is overcome, as competitive network provision spreads, more and more the barriers to adoption of advanced Internet applications will not be the networks, but will be the broader business environment. For example, existing m-commerce operations in developing countries have cooperative arrangements with banks for both practical and regulatory reasons, but this highlights the importance of ensuring that banking regulations permit such innovative approaches.

It is clear that this broader environment becomes ever more important with convergence. Recent World Bank surveys of over 20,000 businesses in roughly 50 different low and middle-income countries suggest that firms using ICT see faster sales growth, higher productivity and faster employment growth. At the same time, the record is clear that the introduction of ICTs is highly complex, with evidence from both developed and developing countries alike of significant failure rates. One study of the introduction of online purchasing systems, for example, found that only 40 percent of companies saved money when they deployed such systems as part of a change management process. Even more revealing is that only three percent of companies managed to save money from online procurement systems, if they were introduced without an accompanying process of change management.

This highlights the vital importance of factors such as skills and business processes within companies and governments, as well as the level of education in the workforce. The institutions required to facilitate online financial systems and commerce in the broader economy are also central to the success of Internet applications. In essence, the main message is that it isn't just the infrastructure any more; rather, in a converged environment, firms working in the ICT sector, and governments overseeing that sector, have to be attuned to a far wider range of influences and trends that will drive success or failure.

Where might we end up?

In such a fast changing industry, trend-spotting is a particularly dangerous occupation. Certainly, there are a host of unknowns. But perhaps the next ten years will see the revival of business and regulatory models that were launched before their time in the last ten years. For business, the sad history of the AOL/Time-Warner merger dampened hype surrounding converged industries, but perhaps recent developments such as Direct TV's moves towards the triple play model suggest that the time may yet come for such businesses. Again, this might leave infrastructure providers as wholesalers to applications and content providers.

For policy and regulatory agencies, if spectrum scarcity really does come to an end while competition spreads, and countries follow the current US-type model (for all but broadcast) of controlling content through law enforcement agencies and the courts rather than an industry-specific body, the role for an independent regulatory body for telecommunications infrastructure becomes questionable. The market may become so competitive that regulation is not required, or so complex and fast-changing that regulation cannot keep up. Whilst New Zealand may have jumped the gun in its attempt to abandon specific regulatory institutions for the sector in the 1990s, the new decade might see the return and spread of this idea.

At the same time, if there is considerable consolidation in wholesale provision, it is equally possible that regulators will have new and considerable responsibilities ensuring a level playing field for retail provider access to the backbone.

Technology and market developments would also have an impact on the relevance of industry associations and development institutions focusing on ICT. If information and communication technologies are truly 'mainstreamed,' to become commoditized and ubiquitous, and if many parts of the industry lose most vestiges of 'natural scarcity,' the role for technology-specific institutions will have to change. The GSMA, for example, was formed for operators around a technology standard but might have to develop towards an association for both communications providers and platform users. Regarding the World Bank Group's role, we understand that this is dependent on understanding client needs and new technology and business models, and will doubtless change in the years ahead.

The joint GSMA, IFC and infoDev study on m-banking is one case of our approach in this area. Technology advances and shifting market dynamics must determine future business models to meet new demands from customers. As the majority of future applications will begin as experiments, establishing best practices for both companies and governments, and the knowledge sources and toolkits on what works and what does not will be needed. We hope to be in the forefront of developing such new approaches with our partners and clients in business and government around the world, with particular focus on the most effective modalities for public-private partnerships to address market and demand gaps.

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[xviii] Wellenius and Neto op. cit.