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END-USER SHARING

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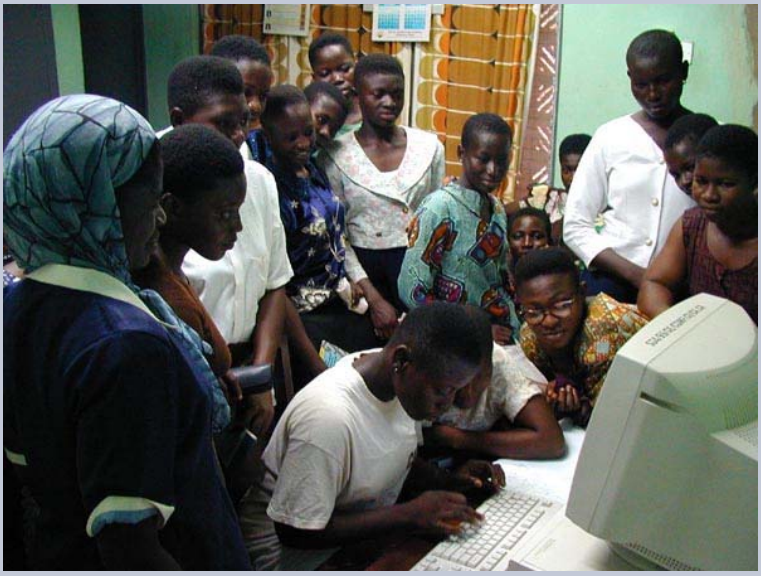
1 INTRODUCTION

Sharing of technologies is a ubiquitous behavior among most of the planet's people. These common acts of sharing by end-users, the actual consumers of the product as opposed to those positioned elsewhere along the product production or delivery value chain, are motivated by disparate reasons. To be sure, especially in low-development settings, sharing is commonly a product of income–poverty both in developed and developing countries, weak infrastructures, scarcity or want. But especially in these contexts technologies are culturally programmed for sharing. A visit to a small rural village in northern Ghana, for example, makes the point. Here all technologies, regardless of their conditions of ownership, are shared among their users: bicycles, a diesel moped, and the village water pump. In particular, information and communication technologies are universally shared among these village inhabitants: the radios and televisions crowded around by neighbors anxious to follow a broadcast football match and the few mobile phones in private ownership shared generally on a cost-recovery basis. The only computers in the village are shared on a for-profit basis at the modest local cybercafé.

If scarcity is the mother of sharing in this village, culture and community is the father. Box1 shows more than a dozen members of the community gathering to share an experience with the single computer. To be sure they are sharing the artifact itself, the personal computer. But they share other elements of the encounter – the expertise of the young man typing, the directions of the teacher looking on, and the encouragements all around. In classroom settings the value of this particular form of end-user sharing has been well understood. In certain environments, collaborative learning experiences, in which multiple students share single machines, have been shown to actually enhance learning outcomes when compared with one-person one-computer experiences.[1,2] Indeed end-user sharing of computers has been shown to enrich collaboration, reduce conflict, encourage peer-learning, and strengthen communication.[3]

Box 1: Many "users" for one computer



Source: M.L. Best

Thus, if scarcity of the personal computer is still not a complete account of the end-user sharing depicted in Box 1, it is even less of an explanation for the sharing depicted in Box 2. In this image three students are crowding around a single computer even in the presence of plenty of available machines visible in the background.

Box 2: Students share a computer even in the presence of plenty of unused machines

Source: M.L. Best

This chapter will explore various end-user sharing models for information and communication technologies and will consider the properties of sharing, the ways that ICTs can encourage and enhance sharing, business models and applications that are predicated on end-user sharing, and the roles of the regulator as it relates to sharing. The telephone will first be discussed, and then the computer, the network, and the broad area of information and knowledge sharing.

2 END-USER PHONE SHARING

Without question the stunning success of mobile telephony has catalyzed the spread of phone services the world over and, in turn, end-user sharing of phones particularly in low-income settings. Indeed, end-user phone sharing has been the most ubiquitous of two-way communication end-user sharing common across the globe, at least in the form of public paid telephones. Until recently public phone boxes were common sites in low- and high-income contexts alike. But today in high-income countries, as mobile phone penetration rates have soared, public phone facilities have been on the decline. In many low and middle-income settings, however, public phone facilities remain common. One report notes that most users in most African countries are likely for the foreseeable future to obtain telephony access primarily through public access facilities – whether booths managed by telecommunications operating companies or privately-managed teleshops.[4]

Several end-user telephone sharing models have been put in place. They can be organized into a simple taxonomy:

1. Unmanned coin- or card-operated public phone boxes often owned by a major incumbent fixed-line operator.
2. Large and branded public phone facilities, sometimes referred to as a Virtual Network Operator (VNO).[5]
3. Entrepreneurial locally-owned and operated Public Call Offices (PCO), often without branding.
4. Local Village Phone Operators (VPO), such as so-called “village phone ladies.”
5. Roaming fixed-wireless phone operators, often with purpose-built telephone terminals that provide point-of-sale billing data.
6. VoIP phone services generally co-located with cybercafés.

Box 3, below, shows an example of four of these options.

Although the widespread adoption of mobile telephony in high-income countries has spurred the decline of shared public phone booths, the opposite is true for low-income areas where formal and informal telephone sharing models remain common. The high prevalence of sharing means that the relatively low subscriber penetration rates often reported can be misleading. With routine informal sharing in addition to prevalent formal private service re-sellers and public access facilities, it is clear that phone use extends far beyond the subscriber base. According to the ITU-infoDev ICT Regulation Toolkit module on Universal Access, even in the presence of low barriers to phone entry including low priced handsets and the low levels of revenue

required per subscriber for most operators, many rural people will still not be able to posses their own telephone and instead will make use of shared access facilities.[6] For the foreseeable future end-user phone sharing will remain a common experience.

Case numbers 3 and 4 from the list above, the PCO and VPO will be discussed at greater length in section 2.1 and 2.2. While option 6, VoIP providers, will be treated in the following section on end-user computer sharing. In addition, the considerable rise in sharing of phone applications that extends well beyond basic voice services will be explored below.

Box 3 - Clockwise from top left: An Eircom unmanned phone booth, an MTN VNO phone office in Kampala, a Grameen Village Phone Operator, and a locally owned and operated PCO in Bihar, India

Source: (from left to right) Eircom, M.L. Best, Grameen, M.L. Best

2.1 Public Call Offices

The public call office, consisting of a locally owned and operated entrepreneurial facility, is a ubiquitous site in many low-income areas. In no place is this more the case than India where the yellow PCO/STD/ISD (Public Call Office, Subscriber Trunk Dialing, International Subscriber Dialing) signs appear, seemingly, on every town's street corners. The Indian PCO phenomena offers a critical case for study of both the importance of end-user telephone sharing as well as the struggles of regulatory liberalization within the ICT sector.

What started slowly and with lengthy administrative procedures and regulatory resistance has blossomed into millions of facilities and, according to India's Department of Telecommunications, a presence in 92 per cent of all Indian Villages.[7] Key to this growth was the establishment of agreeable revenue sharing terms by the Department of Telecommunications; terms that have existed in their current form since their inception in the 1980s. Small scale local entrepreneurs keep 20 per cent of call charges while 80 per cent goes to the phone operator. Twenty years later, with the rise of mobile telephones, the state of these PCOs still seems stable although mobile phones do compete with the PCO[8].

2.2 Village Phone Operators

A PCO often offers service over a fixed-line phone, in a permanent facility, and with formal revenue sharing terms agreed to with the operator. In comparison, the Village Phone Operator is often an individual with a mobile phone and only an informal facility. Famously, in Bangladesh the Grameen Phone network has installed, since 1995, local phone operators who re-sell basic shared communication services. It is estimated to generate net incomes of $624 per operator[9], above the country's average per capita annual income. This program, an offshoot of the Grameen Bank microcredit organization, has leased cell phones to poor rural women who set up local village pay phone shops.[10] In a review of the early experience of the Grameen Phone project, the service was found to be of considerable benefit both to the provider and the users. Not least, the average operator was earning between 24 and 40 per cent of household income from providing phone services and the estimated consumer surplus (the money saved by making the call as opposed to the other options that would have been available including travel) from phone usage ranged as high as USD2.70–USD10.00 per call.[11] A related study, interviewed more than 400 users and operators across 50 villages.[12] They found that the village phone program was particularly pro-poor and led to specific social development outcomes. For instance, the intensity of use among villagers living below the local poverty line was 50 per cent higher than non-poor people and most calls placed by poor users were related to economic matters. In addition, the poor community members enjoyed a much higher consumer surplus for each call compared with non-poor users. These researchers also discovered that by placing the mobile phones in the hands of the women of the village there was a noticeable empowerment of these women with reports of enhanced mobility, decision making powers, knowledge, and confidence among these village females—a powerful social development outcome.

Thus, VPOs have been shown to be valuable examples of phone sharing particularly in rural low-income settings.

2.3 Value-added Services

To date end-user phone sharing has focused on basic outgoing voice services. But in some cases value added or data services are being offered in addition to the incoming and voice messaging services briefly mentioned below. Indeed, some argue that shared mobile phones can act « as an infrastructure service; a financial sector service (virtual currency, electronic accounts or banking); a market, weather, and health information exchange mechanism; and an investment sector service».[13]

2.3.1 Text and Data Sharing over Mobile Phones

Basic text messaging is perhaps the simplest and thus most common value-added shared phone service. A study carried out in South Africa found that inbound text messages for entrepreneurial small-business phone subscribers outweighed outgoing messages by eight to one.[14] The reason for the significant preponderance of incoming text messages is because, they argue, these particular phone owners informally relay text messages to others in their community who either do not own a phone or perhaps cannot read or write. Sometimes this service is offered for a fee, marking a clear example of small-scale and often informal text messaging shared business services.

Moving beyond simple person-to-person text messaging a number of SMS-based agricultural text services have been deployed, some of them focusing on end-user sharing of information.[15] For example in Senegal a collaboration between the French company, Manobi, and the Senegalese mobile operator Sonatel, have offered real-time agricultural price information via text or voice messaging and the internet. One study found that targeted information provided by Manobi allows producers to improve their negotiation capacity as they sell their goods into market.[16] The International Development Research Centre (IDRC), one funder of the project, has estimated that this enhanced negotiation capacity results in 15 per cent higher profits for the farmers.[17] However it was also found that the agricultural commodity chain was not generally altered because farmers are often tied by social links, credit, transport, etc.[18] Although profits increased the overall system of trade was rarely altered.

A similar project, with both SMS and Internet agricultural price services, has been offered by the Zambia National Farmers Union.[19] The Smallholder Enterprise and Marketing Programme (SHEMP) provides agricultural prices for 12 major commodities in response to SMS requests according to a major funder for the program, International Fund for Agricultural Development (IFAD).[20] This price information is disaggregated by district, province, and for the nation, again giving stronger negotiation and decision powers as the information is shared and spread among small scale farmers.

A new agricultural trading system for mobile phones has also been deployed in Africa. Created by a small software development company in Accra,[21] TradeNet aims to link a wide-range of African agricultural traders using mobile phone SMS capabilities. According to popular press reports and web contributions,[22] TradeNet has been piloted for the last 12 months in several African markets, and price and supply-chain information

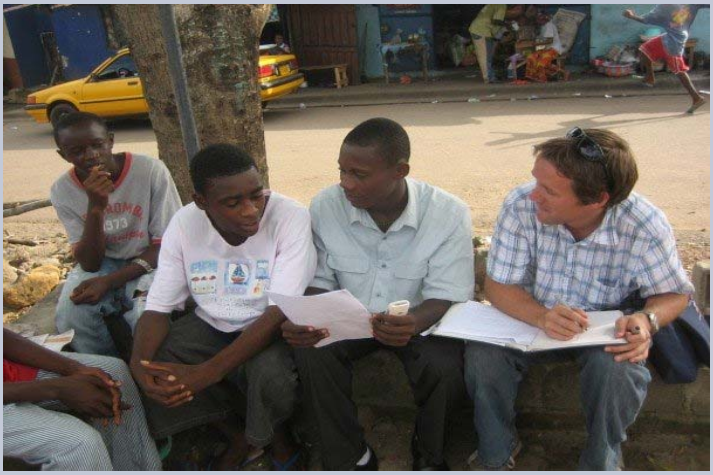
has been collected. According to these online reports, Uganda Foodnet has conducted user satisfaction assessments concluding that 68 per cent of those farmers contacted had used Tradenet to access market information and 91per cent reported that these interactions had a positive impact on their business.[23] (See Box below for the views of TradeNet's founder).

2.3.2 In-coming and Voice Messaging Services

Commercial shared phone services have focused almost exclusively on outgoing calls where an end-user comes to the shared phone facility to place a call to some second party. But incoming calls are also a potential service for shared phone operators. Recent survey work has found that many users would make use of incoming services at public shared phone facilities.[24] Regrettably, two challenges have reduced the frequency and efficiency of this offering. First, consistent business and revenue-sharing models have yet to be developed especially as most all mobile phone networks are caller-pays. Thus there is no clear way to price a received phone call. This provides some scope for regulatory and operator intervention with the creation of a special incoming shared call or message priced service.

Furthermore, technical challenges have inhibited in-coming service scaling. Researchers at the Georgia Institute of Technology recently studied enhanced handsets that support locally managed voicemail boxes. This modest technological affordance would allow local entrepreneurs the option of providing a private extension and message box for local customers. The entrepreneur might price this per message, on a monthly rental basis, or offer it free of charge to regular customers of their outgoing call services. Experiments with a prototype phone system in Liberia suggest that users and local phone entrepreneurs find this service of high value.

Box 4: Developing an in-coming shared voicemail message service in Liberia



Source: John Etherton

2.3.3 M-Commerce

In addition to agriculture information sharing systems over mobile phones, another new and promising area for mobile-phone data and enhanced services is financial and banking services, often referred to as "m-commerce." Basic mobile financial services could include secure savings accounts, non-usurious credit opportunities, currency management, and fund transfers and cash delivery. M-commerce has the potential of removing the biggest obstacle for commercial banks to serve low-income communities, the high transaction costs associated with very modest sized accounts. Mobile banking (and digital banking more broadly) has been shown to significantly lower transaction costs compared with brick-and-mortar banking. Researchers have proposed a taxonomy of m-commerce services:

- joint ventures in which a mobile operator works with a financial services provider to offer services (e.g. Wizzit below),
- m-payment platforms through which typically online service providers offer payment options over mobile networks using multiple banking partners,
- and non-bank driven ventures through which independent companies or public sector organizations offer m-commerce services (e.g. GCash below).[25]

One high-profile example of a mobile banking joint venture program is called Wizzit. Established in 2004, Wizzit has already signed up 50,000 South African customers and hopes to eventually reach 16 million.[26] Users can deposit cash into their cell-based accounts through any post office or the brick-and-mortar bank

branches of two participating financial institutions. There is no minimum balance or annual fee to join the program, but users pay a per-transaction fee of between 15 to 78 US cents.

Box 5: WIZZIT Programme customer findings

The Consultative Group to Assist the Poor (CGAP),[27] have examined the WIZZIT program customers finding that they use WIZZIT « because it is "cheaper" (70 per cent), "safe" (69 per cent), "convenient" (68 per cent) and "fast" (68 per cent). By comparison, customers visiting a brick-and-mortar bank report spending an average of 32 minutes in queue and USD 2.27 to reach a bank branch by bus or other transport ».[28] Thus WIZZIT customers enjoy a consumer surplus and the commercial bank enjoys reduced transaction costs for these (previously unbanked) users.

Another widely reported m-commerce example, GCash, originated in 2004 from a mobile phone operator in the Philippines.[29] This system, described as a virtual wallet, allows a subscriber to deposit money, transfer funds, make remittances, and receive cash. This system was developed by non-bank organizations but was offered special regulatory relief with bilateral agreements between the operator and the Central Bank.[30]

In the Democratic Republic of the Congo Celpay, a company owned by South Africa's FirstRand Banking Group, offers mobile banking services to approximately 25,000 Congolese subscribers.[31] Across the country a set of « human teller machines » man small booths with a mobile phone and cash box. By transferring phone credits through the mobile network people are able to send cash to their family or business associates in even rural areas. In this way, prepaid phone credits become almost a parallel currency to Congo's official franc.

In Kenya a major mobile operator[32] offers money transfers via SMS text messages. This initiative, called M-PESA, has enjoyed fairly wide user adoption with a reported 20,000 subscriptions within the first month of operation. The system supports fairly straight forward financial services aimed at unbanked people. Customers "turn cash into e-money" at a Safaricom dealer. The customer can then transfer the money to other individuals, make cash withdrawals, make direct purchases at participating businesses, or purchase prepaid telephone minutes[33].

In a report authored by the project's principal originators considerable regulatory hurdles to establishing the M-PESA program were identified[34]. When the service was launched, the operator offering the service did not have a banking license nor staff expertise in all appropriate areas. Furthermore, the Central Bank of Kenya clearly needed to be engaged in the process. Over time the expertise and relationships where established and eventually the Central Bank cleared the launch of this m-banking service.

Box 6: First Person Account - Mark Davies, CEO, Busylab on m-commerce and TradeNet

"What is clear to me, is that the potential opportunity for mobile commerce is huge. I believe that mobile networks theoretically connect almost 500 million in Africa to the Internet in the sense that they can be used to send and receive personalized, transactional data. Moreover, each month we discover new potential ways in which these networks can be leveraged. Whereas I think we began TradeNet as a technology solution for Agric projects focusing merely on prices, we now realize that it's not so much about agriculture or about prices, as it is about communities and finding a delivery channel to serve their varied needs. The needs may start with agriculture, but extend to e-government, credit, transport, weather, inventory, health etc. Our focus is to build that delivery channel, which constitutes one part technology, and ninety-nine parts people, to find agents that can replicate some of the innovation behind Grameen phone micro-entrepreneurs, and to extend it to personalized data services, rather than just voice. TradeNet is launching, later in 2008, an 'openmarkets' approach not dissimilar to how Facebook allows third party applications to leverage their profiles and access. So we will create a standard interface to both data sources and mobile operators for any third party application, thus accelerating innovation of services on mobile phones targeted at these communities. And whoever ends up with the best service, and the best data-profiling will become the natural choice for advertisers and businesses seeking to sell new services to the broadest market. I believe that conventional market information services were limited by the scope of commercial services they were hoping to serve. And by providing a channel for commercial activity you can be highly profitable, not just sustainable, and that by collecting the chatter of all your activities and agents as they use their own private tools and spaces on your platform, you back into a public MIS with adequate guarantees over content privacy for paying customers. It's a fascinating challenge, and more about anthropology than technology, as always. All products are defined by their customers, and in the past international donors have been those customers, and thus the usability and relevance of these services to target recipients have mostly missed their mark. By being a commercial service, dependent and driven by the actual end users, we hope to shape a completely different product, and have fun working through all the challenges and mistakes along the way." (source: personal communication)

2.4 Second-hand Phones – the Final Word in End-user Phone Sharing

Perhaps the final way that end-users share phones is through the trading and handing-down of used mobile phone handsets as subscribers up-grade and replace their units. Sometimes this is a formal process, for instance many handset vendors will accept old phones when they sell you a new one. In high-income countries there are also many NGO's who take used handsets, refurbish them, and resell them in low-income settings.

This second-hand phone market is a virtuous cycle thanks to at least two reasons. First it limits the environmental impact of discarded mobile handsets which otherwise might collect in landfills. These discarded phones are made up of significant amounts of plastic; some dangerous heavy metals; and of even more concern, batteries. In addition the second-hand phone market lowers the barriers to entry for many low-income telephone subscribers. Indeed, in many markets used phones can be priced at USD 30 or even less.

In a survey in Bucharest, Romania, researchers discovered that among pre-paid phone users a full one-third had purchased and where using a second-hand phone[35]. In some low-income settings this proportion is likely to be much greater. And the supply of second-hand phones, especially coming from high-income countries, seems inexhaustible. In 2007 over 60% of all handsets worldwide are replacements thus the pool of functioning second-hand mobile phones is substantial.[36] In the United Kingdom alone there are an estimated 90 million old phones in subscriber's possession with15 million phones going out of use every year as people invest in newer units[37].

The second-hand phone market may voice the final word in end-user phone sharing as handsets move from subscriber to reseller to subscriber.

2.5 Conclusion

End-user sharing of telephone services continues to be a critically important mechanism by which many people are able to enjoy basic voice and increasingly value-added network services. As was previously noted, the startling rise of mobile phone penetration has sat Janus faced toward end-user sharing: in some high-income locations mobile phones have supplanted shared phone facilities while in other areas mobile phones are the core technology for voice and data shared services.

Despite these tensions, shared phone services have a rich and robust foreseeable future across much of the planet. But to ensure continued success, regulators must attend to the special requirements of shared service. In a broad study of innovative demand models for telecommunications, one study[38] has noted four barriers to the use of these shared facilities, all admitting to regulatory responses:

- Quality of user environment (notably privacy and queuing),
- Quality of attendant service,
- Quality of network service and call completion,
- Price and methods of payment.

2.5.1 The Role of Regulators

As noted, regulatory reform and support is critical to establish strong m-commerce programs. This is especially true as telecommunications regulation needs to interface with (the often more stringent) banking and finance regulatory regimes. That said, there are a few examples where innovative cutting edge m-commerce innovations have emerged in spite of civil conflict.

Regulators can play a critical role in encouraging end-user sharing, and thus universal access, to telephone services. Some best-practice regulatory policies include:

- Support fair, transparent, and uniform revenue-sharing terms for private small-scale PCO entrepreneurs. These terms can be the one fundamental policy that creates (or could, if poorly defined, destroy) PCO markets. See for example India's experience as described in section 2.1. Basic service operators, including powerful incumbents, need to be reminded of the India example. In this case the government operator initially resisted sharing revenue with PCO operators fearing it would unreasonably drain their income stream. In the end, however, PCOs have proven to be one of the largest sources of revenue for the operators tapping a previously unavailable and under serviced market.
- Create policies that allow individual village phone operators the rights to re-sell voice services without seeking special licenses or paying large fees. Whether formally or informally operated, VPO services have shown to be effective and market competition has generally been very capable at ensuring fair re-selling rates and adequate service. Indeed directly regulating VPO services may be onerous to the point of near impossibility since so many of these operators may "fly below the radar screen".
- Operator training for VNOs, PCO's and indeed VPOs is important and the regulator can help set policy to ensure attendant training, the development of appealing and consistent user experiences, and responsive environments.
- Specialized telephone terminals, or indeed even simple handsets, need to be able to price a call. For systems that allow a range of calls including international and inter-network domestic phoning, specialized pulse-counting technology may be needed. The regulator can help ensure that end-users are charged accordingly by encouraging the development and use of these specialized terminals. In simpler environments it may be enough to just count the seconds the call is connected. Related to this, regulators can encourage more simplified domestic tariff structures (for instance tariffs that do not vary from mobile to fixed line or mobile to mobile) which will make pricing easier to compute and more transparent.
- It is important to encourage data and text services. In the sections below broadband services over hybrid copper/fiber networks will be mentioned. But with respect to mobile operators regulatory policy can be developed that encourage progression towards 2.5 and 3 G (and whatever lies beyond). These underlying network technologies will go a long way in supporting value-added service innovation. This point notwithstanding, it is striking the capabilities and wide uses of simple text messaging services over modest second generation digital mobile networks; how much can be done with seemingly so little should not be under-estimated.
- The regulator's role in encouraging m-commerce technologies is paramount and may require close coordination with banking and financial state regulators including, often, the central bank. Considerations include how and when a service becomes a bank, security and protections against money laundering and irregular market uses, privacy concerns, etc. Best-practice in such coordinated regulatory regimes is only now beginning to emerge globally.
- Second-hand phone markets can be encouraged by supporting operator programs to receive used handsets as subscribers upgrade their units.

3 END-USER COMPUTER SHARING

This chapter will now turn to end-user sharing of computer systems. The most common form of such sharing is what occurs in schools or at a cybercafé or telecenter. Many aspects of computer systems design discourage end-user sharing. Indeed the very name, the personal computer, illustrates how hostile to sharing these technologies may in fact be. But some researchers are attempting to turn the personal computer into

something more sharable by communities of users.[39] This and other innovations will be reviewed in greater detail in this section.

3.1 Cybercafes and telecenters as end-user sharing

The concept of the telecenter emerged from a community driven movement in Scandinavia in the 1980s. Today telecenters can be found in many countries and are referred to by a plethora of terms—tele-cottages, public information access points, public internet access points, multi-purpose communications centers, and others. While each of these terms may represent slight differences in the object being discussed, the common meaning used here are publicly accessible shared computing or Internet resources that are available with or without fees.

Many typologies have been proposed for telecenters which are helpful in organizing our consideration of this shared-use ICT model.[40,41] These include discrimination on the following primary axes:

- Location (e.g. urban vs rural, co-located vs stand alone, in an area of low or high social or economic development)
- Service bundle (e.g. simple computer operations, Internet and email, FAX, training, copying, typing, desktop publishing)
- Organization model (e.g. for profit, not-for-profit, community owned, local entrepreneur, large-scale business, government service centre)

A few studies have helped identify the importance of shared computer facilities especially in low-income settings. A survey of 280 small and medium enterprises (SMEs) conducted across 14 African nations, found that more than half of the respondents reported that the internet was either important or very important to their business.[42] Those findings notwithstanding, the survey found that only 18.7 per cent of responding enterprises had direct access to the internet while 40 per cent had direct access to a computer, and more than 80 per cent have access to a mobile phone. Indeed 40 per cent of the SMEs that stated they did not have direct access to the Internet nevertheless felt that the technology was important or very important to their businesses. (Significantly, 70 per cent of SMEs that did not have a mobile phone felt that technology is important or very important to their businesses.) This dramatic access gap among SMEs is closed in most cases through the use of cybercafés and other shared access facilities. Seventy-two percent of respondents that did not have direct access to the Internet where able to use cybercafés for some access.

3.1.1 Two Examples from Latin America

The National Program of Infocentros (Programa Nacional de Infocentros) is an initiative that started in Chile in 2001 in response to the presidential mandate to coordinate public sector efforts (and private sector partners) to provide Internet access to communities in public shared facilities. These centers provide staff to assist users, Internet-connected computers to access local, regional, national and international information and in some cases fax machines, copying services and televisions. The presidential mandate charged the Chilean regulator, the Subsecretaría de Telecomunicaciones (SUBTEL), to coordinate the Infocentros program within the broader objective that within the 2000-06 period every Chilean citizen will have shared community or individual means of accessing the Internet. The government defined the Infocentros as "a public community facility with ICT capabilities and communication to access and/or generate content and services relevant to the community in which it is located"[43]. The presidential mandate also provided a set of guidelines to guarantee the program's sustainability through community participation, appropriate physical settings, and trained staff to adequately assist users within comfortable and secure facilities. User training programs also were established that served to encourage the creation of local content. This mandate also determined that the funds required to operate the facilities could be obtained from local governments, private sector contributions, public sector institutions and end users.

In accordance with the presidential mandate, these facilities are of a varied nature, they are located in public schools, public libraries, publicly and privately-owned facilities (in the latter case with government subsidies for their installation), youth community centers and NGO coordinated facilities. In its latest report, from November 2006, the government organization created by Subtel to coordinate the national network of Infocentros, the "Coordinación de la Red Nacional de Infocentros" (CONI) identified a total of 729 installed facilities that in 2006 provided services to 955,599 users (approximately 6 per cent of the population). These facilities were deployed in all 12 regions in which Chile is divided to better reach all of the population. This was accomplished through 4001 computers from which 3898 are connected to the Internet. Taking advantage of these resources, 77,307 users received training in basic computing skills at these facilities[44].

These numbers indicate that each computer was shared on average by 238 end users. Therefore the regulator has managed a project that has resulted in considerable end-user computer sharing. As the facilities are located primarily in libraries (approximately 60%), existing infrastructure can be leveraged and

taken advantage of by users drawn there by the computing facility. The same applies for facilities that are located in public education institutions.

A program of similar nature to the one in Chile was established in Colombia in 2000, the Compartel program for Telecentros integrates efforts to bring access to the Internet as well as telephony to rural areas that lack these services. These Telecentros are privately run facilities which provide at least two computers and one telephone booth and are connected primarily through a satellite link to the phone and Internet. Over three phases, a total of 1,490 Telecentros have been deployed varying from facilities with two computers, a telephone line and a fax line to facilities with six to twelve computers, three telephone lines, one fax line, a scanner and web cameras. In total 6,900 computers and 4,907 telephone lines have been installed[45]. The Compartel program is also responsible for the coordination with other government entities required to provide and support Internet connectivity (with private operators) at 7,813 public schools, 1,047 city halls and 200 hospitals and to provide online training at the facilities in a variety of technical fields (in partnership with SENA, the Colombian national training service)[46]. These training courses range in content from arts and sciences to crafts, machinery operation, manufacturing and a large offering in Information Technology.

Box 7: Regulatory and Political Hurdles in the Sustainable Access in Rural India Project

The SARI (Sustainable Access in Rural India) Project aimed to demonstrate that the creation, deployment, and delivery of information and communication services and technologies in poor rural areas leads to improvements in health, empowerment, learning, and economic development amongst the poorest and most disadvantaged communities - and that such services can be realized in an economically sustainable fashion. Begun in 2000 the project grew to include nearly 100 Internet facilities in 50 villages spread throughout the Maduri district of Tamil Nadu, India. The project served to incubate nLogue Communications Pvt. Ltd., a start-up firm that extended and scaled the SARI model to districts throughout India.

A subdistrict headquarters of Madurai, the city of Melur, served as the technical base for the project. The parastatal phone operator, BSNL, has done a very good job of laying fiber throughout the country; indeed most subdistrict headquarters are connect by fiber to the major metropolitan areas and onward to the Internet. In this case, BSNL had fiber capacity stretching from Melur to Madurai city and it was this connectivity that was well suited to backhaul the SARI network connectivity. A request was submitted to lease fiber capacity from BSNL on usual commercial terms. Such a lease was a fairly standard matter and would usually take a month to prosecute. The SARI project waited one year for the network capacity to be sanctioned. The officials of the local BSNL calling circle cited the project's technical capacity to engage in unlawful VOIP services (since that time many VOIP services have been allowed in India). In Delhi additional political considerations were cited.

In this example political hurdles were placed before the project which ensured a substantial delay in its inauguration, and ultimately a delay in the availability of shared Internet facilities in this part of India. The impasse was cleared ultimately in a meeting attended by the communications Minister, BSNL's managing director, and the chair of the regulatory commission. This offers a clear example where a strong independent regulator, able to resolve disputes on commercial telecom activities, plays a crucial role in the deployment of shared computer services.

Box 8: Cybercafe case study - the eCenter project in Krygyzstan

Kyrgyzstan is a small Central Asian low-income landlocked country. It has achieved economic growth of around 4 per cent between 2000–2005.[47] The national estimate of people living below the poverty line was 39 per cent in 2003 with larger percentages in rural areas.[48] In 2002 the government approved a "National Strategy for ICT Development in the Kyrgyz Republic" as part of its attempt to use ICTs to address development issues. However, the growth of the Internet has been hampered by the monopolistic situation that prevailed in the telecommunication market up until recently. One consequence of this is that Internet subscription costs are high relative to average incomes. Few people of Kyrgyzstan use the Internet, with recent estimates (2006) putting Internet user rates at around 5.5 per cent.[49] In addition, PC ownership and mobile phone subscriptions are also low and were estimated at 1.9 per cent (in 2005)[50] and 10.29 per cent (in 2006)[51]. The need to provide shared alternatives for ICT access becomes important in this context and provides the rationale behind the eCenter project.

The eCenter project was launched in Kyrgyzstan in July 2005.[52] The goal of the project was to augment and network a group of telecenters across the country with the aim of promoting local economic development. Specifically, the centers sought to improve local access to ICTs through shared access, stimulate local business creation, improve computer skills, and increase opportunities in non-traditional employment training and job creation among the local population. Local project management was provided by the Civil Initiative on Internet Policy (CIIP)[53], a Kyrgyz non-governmental organization that focuses on the promotion of civil society interests in the development of national ICT policy.

Each of the eCenters provides a variety of fee-based services including Internet access and email, printing, scanning, copying, faxing, multi-media services and IP-telephony. The exact suite of services offered varies from center to center. Each center also delivers a curriculum of computer literacy courses which consist of several modules: Windows, Microsoft Word, Microsoft Excel and using the Internet. Additionally, some centers offer accounting courses and one offers leadership training.

User Interviews from the eCenter Program

A series of interviews were conducted to gauge user satisfaction with the shared eCenter services. Table 1 below summarizes the user distribution across the various centers. Most users were women and typically were young, suggesting the propensity to use ICTs is linked to age particularly where the general diffusion of such ICTs is low (i.e. rural areas). The education rates are similar to those nationally. Also, the user distribution was approximately proportional to the religious and ethnic composition of each community.

Box Table 1 - Summary of user characteristics

eCenter	Male %	Female %	Average age	Bachelors or higher %
Karakol	44	56	21	48
Bosteri	25	75	18	10
Ivanovka	53	47	18	5
Talas	33	67	23	15
Nookat	67	33	24	24
Karasuu	41	59	21	30
Naryn	31	69	24	47
Total for all users	43	57	21	32

Each respondent to the user survey was also asked to indicate how often they used a set of 24 eCenter services ranging from web-design, games, typing/printing documents to Internet use. They were instructed

to rate their frequency of use on a six point scale from "several times a day" to "less then every few weeks" to "never". Overall, the services most used were the Internet, Microsoft office applications, and photocopying and printing documents. While this represented the popular response, identifying patterns in the frequency of use of these services was also of interest[54].

Three distinct user archetypes were identified among these user group usage profiles: There are new-users which make up 21 per cent of those within a user group, minimal-users that make up just 7 per cent, and super-users that make up 72 per cent. The new-users are most interested in the Internet coupons, course papers, phone cards, and FAXs; using these all, on average, once a day. The super-users, however, report frequent use of nearly all of the twenty-four surveyed services except for instant messaging. The most frequent service the super-users report employing is Skype. And, finally, the minimal-users do not report engaging any service with real frequency; for them the most common service they use is Microsoft Office and second most common is game playing but in both cases the average respondent said they used these services only once or twice a week.

The different approaches to the center for each of the user archetypes reveal that new-users and super-users visit the center much more than the minimal-users. The findings also show that super-users are the principal beneficiary of the coupon program. For example 57 per cent of such users report having received coupons for the Internet at this center whereas only 6 per cent and 1 per cent of low-level and new-users have participated in the program.

In general, the majority of users viewed the eCenters positively. When asked to be more specific in terms of their own experiences, typical comments included a satisfaction with the range of ICT services provided at the eCenter, good location, competitive prices, and also appreciation of the assistance and service of the staff. In fact, several users suggested that service was one of the advantages that the center had over other Internet café's where the staff was less likely to spend the time or effort to assist users with their activities.

3.2 Co-present Computer Sharing

Co-present computer sharing describes the condition where multiple individuals are sharing the same computer system at the same time. While this form of sharing can occur in telecenter environments, like those described above, this is not always the case; often individuals use their own machine while sharing only the overall telecenter space, peripheral devices, and personnel. Co-present sharing of a single machine can take at least three forms:

- Standard co-present computer sharing where multiple people gather around a single machine (recall 1 above). This is the simplest and most common form of co-present sharing routinely experienced in many cybercafes and schools.
- Single display groupware sharing, where a computer system supports only a single output device (a single display) but includes multiple input devices (e.g. multiple mice). In this experience the system is configured specifically to support co-present sharing around a collaborative task.
- And co-present groupware sharing where both multiple input and output devices are employed by multiple users. In this case the machine is configured to support co-present sharing but often where each individual works on his or her own task.

This section focuses on systems that support these last two cases, first in schools and then among small and medium enterprises (SME's).

3.2.1 Co-present Sharing in Schools

End-user sharing of PC's amongst students is ubiquitous, especially in low-income settings. A survey on classroom computer use within four different states in India noted that "during 28 field observations, we found no cases where only one child was at a single computer terminal."[55] At times, as many as 10 children grouped around one computer".[56] As mentioned above, this computer sharing is an outcome of resource constraints as well as social and pedagogical motivations; indeed, sharing can enhance communication, collaboration, and learning.[57]

A particular arrangement to support shared display groupware for children has been developed by Microsoft Research. In this system multiple mice are connected to a single computer machine (Box 9). Each mouse will control an individual's uniquely colored cursor on a single shared screen. In one experiment, a software company's research arm in India (compared learning levels in an English language retention task between students individually operating a standard computer and groups of students using a single display, multiple mouse system.[58] In the case of the single display groupware system five students worked together with one

machine. It was found that students using the "multimouse" configurations performed equally well as those using single mouse/single user systems for this retention task. Moreover, in some cases the multimouse systems resulted in enhanced learning outcomes, for instance amongst boys when they were required to collaborate on the learning activity.

Box 9: Multi-point system with multiple mice for a single PC

Source: Microsoft Research

3.2.2 Co-present sharing in Other Settings

In addition to end-user computer sharing in telecenters and single display sharing in schools experiments have also examined end-user computer sharing in business environments. The same motivating factors have been sited: sharing as a cost-saving and sharing as an approach to enhance collaboration and communication.

In business settings, such as SME's, both of these motivating factors may well be obtained. One group of researchers has developed sophisticated stereoscopic display systems which produce individualized private output for two co-present users.[59] In order to accomplish this, users are required to wear specially instrumented glasses that synchronize with alternating display refreshes.

While this complex stereoscopic system may not have broad application, simpler co-present computer sharing technologies have also been developed. Microsoft Research India have developed a split-screen system especially targeted to small and medium businesses in low-income settings.[60] As the name suggests, here the single display is split vertically and two users are provided with their own keyboard and mouse.). Usability and effectiveness studies for this configuration are in the planning phases.

Box 10: Split-Screen PC Sharing for SME's

Source: Microsoft Research

3.3 Low-cost Appliances and End-User Sharing

The previous section discussed technological innovations that support end-user sharing of personal computers amongst co-located individuals. Indeed, the term « personal computer » loses meaning in these situations where the computer is shared and thus necessarily not personal but instead communal. Indeed end-user sharing of computers calls out for community computer designs as opposed to the personal computer.

This point notwithstanding, much attention has been recently placed on providing individual and therefore personal laptops to the children of the world. The number of low-cost computer designs (in some cases, also referred to as ultra low cost devices) offered by research groups, civil society, the public and private sectors has flourished in recent times with as many as fifty separate projects currently listed by the World Bank.[61] By far the project that has garnered the most media attention, and therefore been most responsible for accelerating the low-cost laptop market and driving major equipment vendors into the space, is One Laptop Per Child's XO. This project was launched by faculty and researchers from MIT's Media Lab. Whether this particular effort will yield successes or failure is still an open question as field pilots and evaluations have only just begun, with mixed outcomes, at the time of this writing. And the keyboard is famously small – perfect for that of an individual child but perhaps too restrictive for an adult or multiple children sharing the system.

But beyond the OLPC the larger question remains: Is the one-to-one computer model advocated by the OLPC design and related organizations the best or only appropriate approach to computing globally? Are resource constraints the principle challenge and all that is required is a system that is more affordable? Or, instead, is the sharing of technology a sufficiently strong and pedagogically valued model for many contexts?

Box 11: OLPC - all his and no longer needs to share?

3.3.1 Jhai PC / Jhai Network

Among the many other low-cost computer systems in production or under development is the Jhai PC 2.0, which is just now undergoing an initial field deployment in Laos. While the OLPC is modeled as a stand-along laptop with network connectivity, the Jhai PC 2.0 is a thin client/server technology based on the netPC system.[62] In this client/server model a simplified desktop computer (Box 12) is provided for the end-user. This computer system is not a stand-alone fully functioning personal computer and does not have full system capabilities. Instead it connects via a fast local network (e.g. Ethernet) to a server which is running a full operating system (e.g. Windows or Linux) along with a suite of applications. The server then provides to each client access to the OS environment along with the set of applications. One immediate advantage to this model is that the client appliances can be very cheap and low-power consuming while still functioning with full capabilities provisioned by the server. Furthermore, these systems should be easier for an administrator to maintain and upgrade since all clients would ultimately be controlled by a single server offering a single point of control and failure. A down-side for such a system model, however, is that the clients must be always connected to the server via a fast network and if the server system is not suitably sized for its workload then client performance may be profoundly affected.

Box 12: The Jhai PC 2.0. A client/server model that is supportive of end-user sharing?

Source: Jhai Foundation

In principle this client/server model should enhance end-user sharing capabilities. The close technical relationship between clients sharing a single server could support highly collaborative environments, file sharing, and multi-user applications since there is a far closer technical tie between the thin clients all sharing a single server.[63] Here too, however, the jury is still out. Initial test deployments are now under way in Laos and should soon provide indications on the effectiveness or not of this model.

3.4 End-user computer sharing as an *assistive design*

Conditions when end-user sharing of computers may be preferred to stand-alone computer use have previously been discussed. One additional and important case for such sharing is the example of human-to-system intermediation as an assistive affordance—when a computer operator uses the system at the behest of another person.

In the United States, consideration of end-user intermediation has focused particularly on workplace or household personal assistance services for people with mental or physical disabilities.[64] In these cases intermediaries may assist computer users who, for instance, do not have full hand or arm mobility and thus cannot manage a mouse or keyboard.

Box 13: Assistive end-user operator intermediation in the SARI project

Source: Elcot

In other settings end-user intermediation is often offered when the assisted individual does not enjoy sufficient print or computer literacy. In these cases a computer expert or operator, a friend, or a colleague provides assistance with the use of the machine. In a long-term study of rural computer use in Tamil Nadu, India, these cases of end-user intermediation in commercial telekiosks were examined. One study reported

the results of interviews that asked 25 rural kiosk operators to describe their typical user. Of those 25 operators, 11 indicated that « many » or « some » of their customers were illiterate and thus would require intermediation to account for print literacy requirements. In addition, 18 operators stated that « many » or « some » of their users where computer novices and thus would require assistance to account for lack of computer literacy. In summary, the study revealed that at least half of the operators found that all but a few of their users required some form of intermediation as a shared assistive intervention.

3.5 Conclusions

So much has been written on the telecentre movement. Many successes have been observed but, similarly, there have been a significant number of failures. What cannot be argued against is that telecentres are the most predominant form of end-user computer sharing in many parts of the world. They can solve market access failures as well as help with capacity building and assistive use. Similarly, computers in schools are ubiquitous in many nations and a weighty literature has weighed the pros and cons of such interventions.

Compared to telecentres and computers in schools, however, very few experiments in novel systems for end-user computer sharing have been attempted. Some of the few adaptations include new input and output affordances for otherwise traditional computer systems (such as the multiple mouse system above). Sharing also touches on the growing interest in low-cost computer appliances generally targeted for one-person one-computer environments. An open question remains as to how these innovations will support (or diminish) sharing among users.

3.5.1 The Role of Regulators

Regulators can play a critical role in the support of end-user computer and Internet sharing. In general computing and the Internet have sat under much lighter regulatory frameworks as compared to basic voice services and it is recommended that this trend continue.

- End-user sharing via telecentres and cyber cafes can best be supported by continued light weight regulatory requirements on such businesses. It is often useful for ISP licenses to allow certain forms of capacity re-selling as well such that a telecentre can also share its bandwidth. In addition, as seen in the example from Colombia above, regulators can drive the establishment of shared-use telecentres and are critical proponents for such projects.
- Regulatory relief, public-private partnerships, and the application of universal service funds when available can help support computers-in-school initiatives. Here too cross-government coordination can be of use; regulators cooperating with the Ministry of Education can develop organized approaches to encourage these programs.
- Much is known about the role of the regulator to encourage broadband access and it is beyond the scope of this paper to overview those findings. Nonetheless it is worth remembering the prominent role played by regulators in this regard.
- Regulators can impose assistive design affordances in some contexts or make use of universal service funds for this purpose.

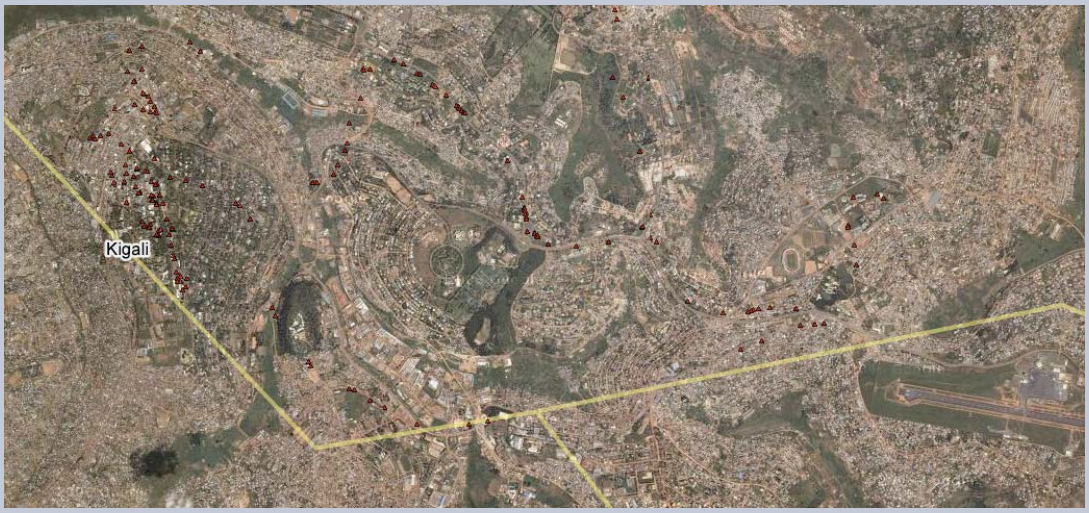
4 End-User Network Sharing

Sharing of computer networks is a constant insofar as all network providers co-locate user data over shared capacity pipes. But end-user sharing of computer networks means something a bit different. In particular, many Internet subscribers will share their capacity with friends (or strangers) by deploying open Wi-Fi hotspots. Nicholas Negroponte of MIT has likened this form of sharing to putting flower pots outside the windows of your home. The flowers are visible to the home owner inside but also are visible to all neighbors and people passing by; all these people are sharing the enjoyment of the flowers. An open Wi-Fi access point might provide a similar type of end-user sharing with the network used by the owner but open to use by neighbors or strangers passing by as well.

Researchers have studied the percentage of Wi-Fi access points that are open thus allowing free access[65]. For example JiWire[66] have estimated that the city of Paris in France has 424 freely open and shared access points compared with their 3,981 closed or pay networks (more than 10 per cent are free and shared). Boston, Massachusetts has 424 free and 3981 pay (over 10 per cednt free) and San Francisco, in the United States has 371 free and 1,025 pay (nearly one third open and shared).

Research done in 2007 by the Georgia Institute of Technology and a wireless location service provider[67] have detected 221 Wi-Fi access points in downtown Kigali, Rwanda (see Box 14) with 42 appearing to be open and shared. Similarly, downtown Monrovia, Liberia had 55 access points detected (see Box 15) with 10 open and shared.

Box 13: Wi-Fi access points detected in downtown Kigali, Rwanda. Each black dot represents a hotspot



Source: M.L. Best

It appears that end-user sharing of Wi-Fi networks follows similar patters worldwide with from 10-30 per cent of networks detected openly shared. Indeed we see this pattern in disparate communities ranging from San Francisco, California to Monrovia, Liberia.

Box 13: Wifi access points detected in downtown Monrovia, Liberia. Each black dot represents a network

Source: M.L. Best

4.1.1 The Role of Regulators

End-user non-commercial sharing of network capacity is at times prohibited either by the Internet service provider user's licenses or by regulation. But non-commercial sharing has not been shown to have significant market impacts and should generally be allowed. One concern is that open (shared) Wi-Fi networks, ostensibly, provide a network security risk. But given the current security and encryption protocols available under standard Wi-Fi technologies (802.11b, 802.11g) security is only properly realized through user managed end-to-end application level encryption. In this way, an open network is only marginally less secure under current popular protocols and the benefits of openness may outweigh the costs.

5 CONCLUSIONS

End-user sharing of information and communication technologies is ubiquitous. Research demonstrates that this sharing can satisfy desiderata of interests including:

- reduced costs,
- greatly increased access,
- enhanced collaboration and communication,
- added assistance for people with special needs,
- novel applications and innovative services,
- and improved learning outcomes.

Sharing of basic phone service, text and data services over the phone, computer and internet services all have broad applications. Furthermore, end-user sharing of network capacity is a common practice at least as open Wi-Fi networks are concerned.

Regulators have a critical role to play in the development of robust end-user sharing experiences. The overall primary considerations a regulator needs to address with respect to such sharing include:

- ensuring a competitive level playing field among operators where market elements are complimented and not constrained by end-user sharing,
- consumer protection including minimal service levels,
- data privacy, security, and protection,
- delivering on universal service aspirations,
- human capacity building in all relevant areas,
- high-capacity networks and innovative services,
- protect users, especially youth, and ensure data privacy as social networking sites and facilities increase in presence and use.

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