Antelope Consulting

FINAL, JULY 2001

DFID Internet Costs Study

The costs of Internet access in developing countries: overview report

CLAIRE MILNE, 15 OCTOBER 2001

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Executive Summary

This study aims to assess the costs of accessing the Internet in developing countries, with particular reference to the international component of costs. It does this through six country case studies, a review of the law on Internet interconnection, and a broad review of the literature and other available information.

International Internet connections are provided by two technologies, fibre optic cables and satellite. Of these, cable is normally the cheaper for all but low volume applications. Cable economics mean that unit costs fall dramatically with volume. Cable does not yet reach many poor and/or landlocked countries, which therefore remain dependent on satellite connections.

Our overall findings on costs were:

They varied considerably among the case study countries, generally being lower in the larger and more competitive ones. In US $ terms, most users with local call charge access are paying in keeping with prices in developed countries. Those needing national call access, and business users with dedicated lines, however, are paying well over the odds, especially in some countries.

ISP costs generally account for under half of end user costs, with telco charges (especially for higher users) comprising the greater portion.

International connectivity is generally in the range of 20% to 35% of ISP costs, with a higher proportion in Cambodia.

ISPs usually purchase global Internet connectivity (ultimately provided by international backbone providers (IBPs)) bundled with the international leased circuits needed to reach the IBP's network access point. Most did not know, or were unwilling to say, how the price paid was split between these elements. The evidence available to us suggests that global connectivity usually accounts for less than 10% of the total price.

The legal review identifies the potential for anticompetitive practices in the IBP market, especially in the light of increasing concentration in the industry. It shows how remedies could be developed on the basis of existing law.

Technological advances of relevance to developing countries are identified. The effect of most of them will be to lower Internet costs somewhat, although a necessary move to expand Internet address space could raise costs if pursued too soon.

In all our case study countries, Internet markets are growing even at current price levels and we expect prices to fall accordingly. We identify policy options which could accelerate this process in the following areas:

Liberalisation and regulation of telecoms within the developing countries, with a primary focus on effective competition for both international and domestic leased circuits, and on permitting Internet telephony.

Sharing between developing country carriers and ISPs the revenues paid by users for calls to the Internet.

Making better use of scarce international bandwidth, for example by setting up local and regional Internet exchange points and by caching content.

Developing alternative lower-cost technologies, with a focus on wireless and cheap terminal equipment.

Monitoring the competitive situation for the supply to developing countries of international bandwidth, and intensifying competion by helping developing country ISPs to get best available buys.

However, in our view the fundamental problem of the four least developed countries that we studied remains extreme poverty, leading to small markets and an inability to take advantage of economies of scale. Increased Internet takeup by businesses and institutions, better-off personal users and telecentres will build market size and attract more effective competition wherever this is permitted.

Highlights from the country case study reports follow.

Cambodia has the smallest Internet industry and user base, and the highest international capacity costs – but these may reflect the fact that the Internet service provider (ISP) in question is owned by the incumbent. Internet growth is restricted by the low number of fixed lines (mobiles outnumber fixed lines 9 to 1) as well as by high prices to end users. Competition is permitted except for international voice, but to date the small market and unclear regulatory environment have attracted few entrants, and competition has not become effective outside the mobile industry.

India's Internet industry is flourishing, taking advantage of step-by-step liberalisation. A recent step has been to permit competition to provide international Internet capacity, and price cuts have already been announced in anticipation of competitive entry. Despite a low per capita income, India has more Internet users per head of population than the rest of our case study countries, except South Africa. Users are heavily concentrated in the economically important western states. Internet access prices for end users have fallen fast and are now low in US $ terms.

Nepal's end user prices are moderate in US $ terms and its international capacity costs in the middle of the range that we found. Price falls followed hard on the decision to permit independent provision of small satellite dish links in 1999. However the industry and user base remain small. The main barriers to growth are perceived as the limited size and poor state of the telephone network, and low literacy levels.

In keeping with its much higher per capita income, South Africa has by far the largest per capita Internet user base, predominantly composed of business users. Government efforts to spread the telephone network and Internet access to poor areas have so far had limited effect. International Internet capacity is provided only through Telkom, which retains exclusivity until 2002. Its costs are expected to come down by a factor of four or five once competition becomes effective.

Uganda has high end user costs despite a relatively liberalised environment. However the second fixed network operator has only recently started operations, and a moratorium has been imposed on new VSAT licensing. Dial-up prices are especially high for rural users who have to pay long-distance call charges, and supplying access numbers charged at uniform national rates, allowing call revenue to be shared with ISPs, is therefore a priority. Actual costs of international capacity are in the middle of the range we found.

Zambia's Internet industry is growing fast, with the main barrier perceived as the poor state of the fixed telephone network. Concerns were also expressed about unfair competition by the incumbent. Usage charges are very high for users needing national call access. Again international capacity costs are in the middle range. ISP licensing fees are a significant burden.

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1 Introduction

1.1 Background to the study

The UK Department for International Development (DFID), in consultation with the Department of Trade and Industry (DTI), commissioned this study as a contribution to understanding the cost structure of Internet access in developing countries. The terms of reference are reproduced in full as Appendix L. The following factors led to the decision to commission a set of country case studies:

The international consensus that the international digital divide is a major issue that must be addressed.

The widespread belief that one of the key barriers is the high cost of accessing the Internet, which in most developing countries is well above that in the developed world and prohibitively high for most potential local consumers.

Consensus on the need for liberalisation of developing country telecoms markets, coupled with

Debate on the international "rules of the game", with particular reference to the APEC TEL proposals for sharing the costs of international links carrying Internet traffic.

Concerns as to whether competition functions adequately for low volumes of Internet transit traffic.

The terms of reference for the study refer to costs of physical Internet access. Of course, physical access alone may be of very little use, especially to new Internet users. We acknowledge the great importance of, and additional costs entailed by, the provision of appropriate content and support services. However we cannot discuss these further here[1].

[1] Indeed, physical access cost may itself be only a minor component of the cost of useful Internet access. A 1996 study in New York State suggested that physical access was rarely more than 10 to 15% of the total cost of deploying Internet technology in schools (NYSERNet, *Network Access Use and Costs in K-12 Schools and Libraries*, 1996, quoted in *Network Cities and the Global Structure of the Internet,* Anthony M Townsend, American Behavioural Scientist February 2001.) A rule of thumb quoted in the UK in relation to providing public Internet access points is that "for every pound spent on equipment, another pound should be allowed for maintenance and another pound for training". Such ratios and rules of thumb will of course take different values in developing countries.

1.2 How the study was carried out

During April 2001, team members gathered information (mainly through interviews) in our case study countries. These aim to represent both larger and smaller countries in Africa and South Asia:

Full case studies: India, Nepal, South Africa, Zambia.

"Mini case studies": Cambodia, Uganda[2].

Other components of the study carried out in parallel included:

A review of the relevant legal and regulatory framework for Internet interconnection, together with an analysis of the terms commonly found in Internet interconnection agreements (often referred to as peering and transit agreements);

A review of the recent country case studies carried out by the ITU on Internet diffusion and Internet telephony;

A broad literature review and search for other relevant information and views.

This overview report aims to synthesize the major findings from the exercise as a whole. Attachments 2 and 3 summarise the specific country case study findings. Full reports for all six country case studies, and also for the legal review and for the review of ITU country case studies, are available separately as appendices to this report, along with a selected reading list and a glossary.

Readers unfamiliar with the Internet may find useful the background briefing included at Appendix GA to Appendix G[3]. The first part of Attachment 5 explains an approach to mapping the Internet which illuminates the unconnectedness of the developing world.

Many people have helped the team of consultants and we would like to thank them all. Please see the Acknowledgments at Attachment 1. We remain pleased to hear from any reader who could add to the findings or would like to debate the conclusions.

[2] In these countries a single interview was carried out, in each case with the largest ISP.
[3] More general introductory material is widely available. See for example http://www.matrix.net/research/library/how_the_Internet_works.html or http://navigators.com/sessphys.html

2 International Internet infrastructure

Figure 1 illustrates the presence in Asia, Australia and Africa of some major IBPs. We see that they barely touch the developing countries of the region, and have announced no plans to expand into these markets.

IBP	Tokyo	Sydney	Singa-pore	Hong Kong	Other Asia	Johan-nesburg	Other Africa	Plans to expand
AT&T	y	y		y	M anila, Jakarta, K arachi, Seoul, K uala Lumpur	Y	C airo	
Cable & Wireless	y	y						O saka
Worldcom / Uunet	y	y	y	y				S eoul, T aipei
Teleglobe	y			y				
Level 3	y			y				
Genuity	y	y						
PSInet	y	y		y	S eoul, Manila			
Multacom					B eijing, G uangzhou, T aipei, S hanghai			A sia
Exodus	y	y	y					A sia, C hina
Infonet	y	y	y		M anila, Kuala L umpur	Y		

Figure 1 Cable-based Internet backbone providers in Asia and Africa[4]

Two physical means of connecting telecoms systems over long distances are in general use: fibre optic cable and satellite. Recent years have seen a boom in installation of submarine cables around the world, of ever-increasing capacity and accompanied by dramatic falls in the cost of the bandwidth that they carry. But the effect has been most marked across the Atlantic: between 1999 and 2001 the price of 155Mbps across the Atlantic fell by a factor of 10. It is now the same as the cost of 2Mbps across the Pacific[5]. Additional cable is now being installed across the Pacific, which may be expected to lead to falls in transpacific cable

[4] All information is taken from the Boardwatch online backbone directory at http://www.ispworld.com/isp/bb/Backbone_Profiles.htm. This means it is as supplied by the companies themselves, dated 2 April 2001.

[5] Band-X

bandwidth prices. At present there is a rather thin provision of cable to South Asia and very thin provision to Africa[6]. However, it is normal practice to install branching points in submarine cable, to enable spurs to be opened to countries passed but not yet connected, when demand warrants.

An important underlying economic factor is the large "quantity discount" available to customers for higher bandwidths on cable. For example, a tenfold increase in bandwidth may be obtained for only a threefold increase in price paid. Figure 2 illustrates this effect[7].

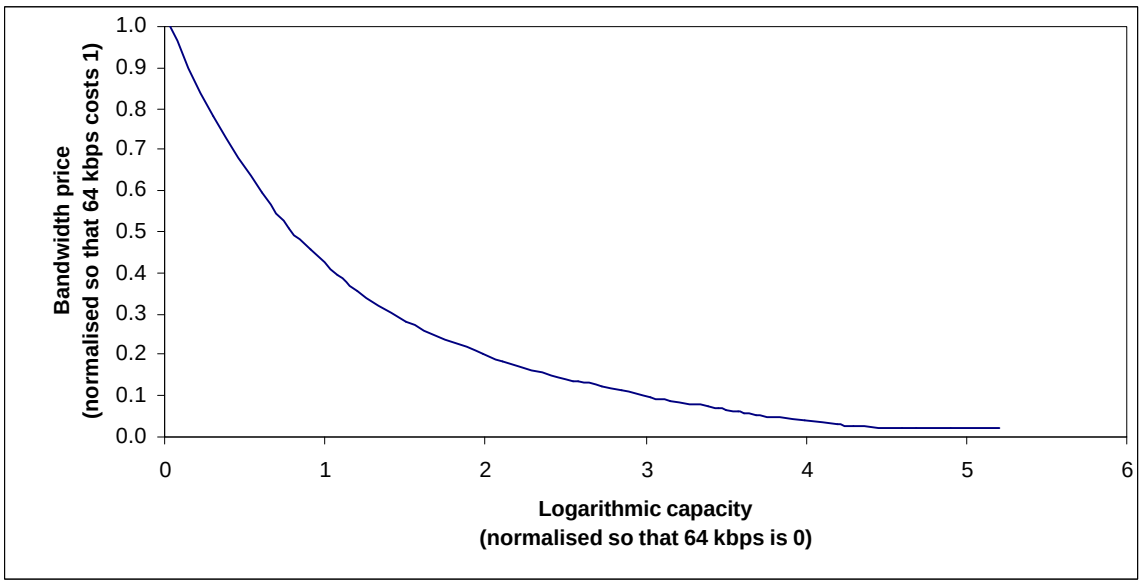


Figure 2 Cable bandwidth economies of scale

For developing countries, important consequences include:

They will start by paying higher prices per megabit per second when their total volume requirements are low.

Major savings may be obtained by traffic aggregation (for example, by co-operation among the ISPs in a country at a not-for-profit Internet exchange).

Where cable transmission is available, it is likely to be cheaper than satellite transmission for even moderate bandwidth requirements.

[6] See for example the Alcatel cable map at http://www.alcatel.com/submarine/refs/cibles/maps/world.pdf; also Section 2 of Appendix H for a map of a new African submarine cable.

[7] This curve is derived from actual quoted prices from various service providers by removing irregularities due to the granularity of capacity provision at low bandwidths. 1 on the x axis corresponds to 10 x 64 kbps, 2 to 100 x 64 kbps, and so on. The bandwidth available from a single wavelength is currently about 10 gigabits per second, which amounts to about 5.2 on the x axis; one fibre can carry many wavelengths and one cable contains many fibres.

Moreover, its large capacity makes it the medium of choice for any demand that is expected to grow to several megabits per second.

Luckily for countries with no international cable connections, whether because of no coastline, difficult terrain or low bandwidth requirements, geo-stationary satellite services reach everywhere on the earth's surface (apart from the polar regions). However, global satellite capacity is much less than global cable capacity. In recent years capacity has risen and costs have fallen here too, though much less dramatically than for cable. However satellite transmission does not offer the same economies of scale as cable and can rapidly become expensive for higher bandwidth requirements.

Nonetheless, satellite is the long-distance technology of choice where cable is unavailable or where bandwidth requirements are low[8], for example for individual isolated or travelling users[9]. Satellite systems are also better adapted than cable systems to providing broadcast and unidirectional transmission. The latter can be put to good effect in asymmetrical services[10].

A fuller account of relevant technical developments is provided in Attachment 5.

[8] For a full treatment, see *Internet via Satellite 2001*, DTT Consulting, available at http://www.spotbeam.com.

[9] Using Very Small Aperture Terminals (VSATs).

[10] For example, World Wide Web access can exploit higher bandwidth unidirectional capacity provided by a satellite link in conjunction with lower bandwidth bidirectional capacity provided by a telephone network to provide faster access for individual users or local storage of popular content ('caches').

3 Overview of cost findings

3.1 End user costs in the case study countries

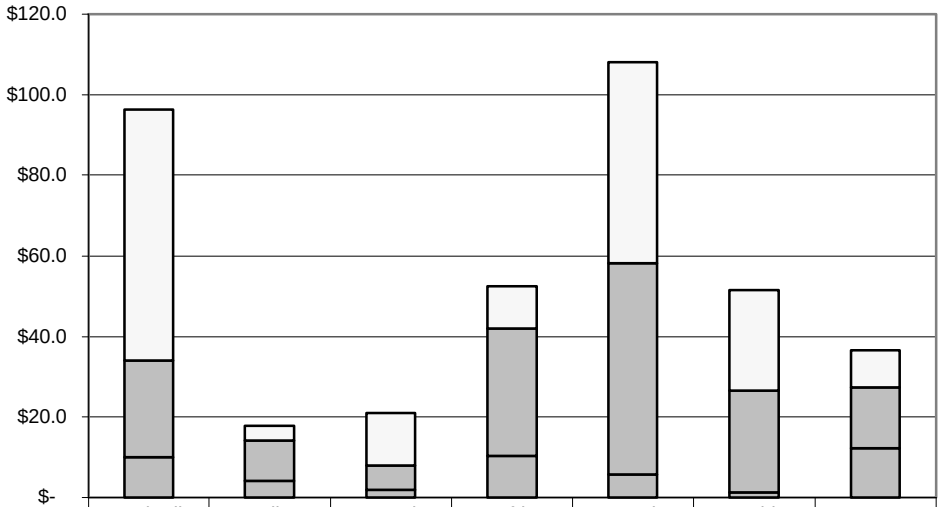
3.1.1 Costs for different classes of end user

	Est. average monthly usage per dial-up account	Cybercafé 5 hrs per month	Local dial-up access 5 hrs per month	National dial-up access 5 hrs per month	Local dial-up access 10 hrs per month	National dial-up access 10 hrs per month	Local dial-up access 20 hrs per month	National dial-up access 20 hrs per month	Direct connection 64 kbps monthly charge
Cambodia	10 hours	$13	$46	$85	$57	$135	$96	$252	$2,583
ISP %	(assumed)		60%	33%	57%	26%	41%	24%	
India	26 hours	$3	$10	$10	$13	$13	$18	$18	$692
ISP %			9%	9%	28%	28%	20%	20%	
Nepal	28 hours	$4	$17	$58	$19	$100	$21	$184	$570
ISP %			71%	23%	61%	13%	48%	7%	
South Africa	10 hours	$19	$29	$29	$37	$36	$53	$52	$617
ISP %			37%	37%	29%	29%	20%	20%	
Uganda	10 hours	$17	$69	$90	$82	$125	$108	$194	
ISP %			73%	55%	61%	40%	46%	26%	
Zambia	6.5 hours	$17	$33	$141	$39	$255	$52	$483	$350 to $800
ISP %			77%	18%	64%	10%	48%	5%	

Figure 3 Typical end user Internet costs in the case study countries (US$)
and for dial-up users, percentage of this paid to the ISP (Source: DFID case studies)

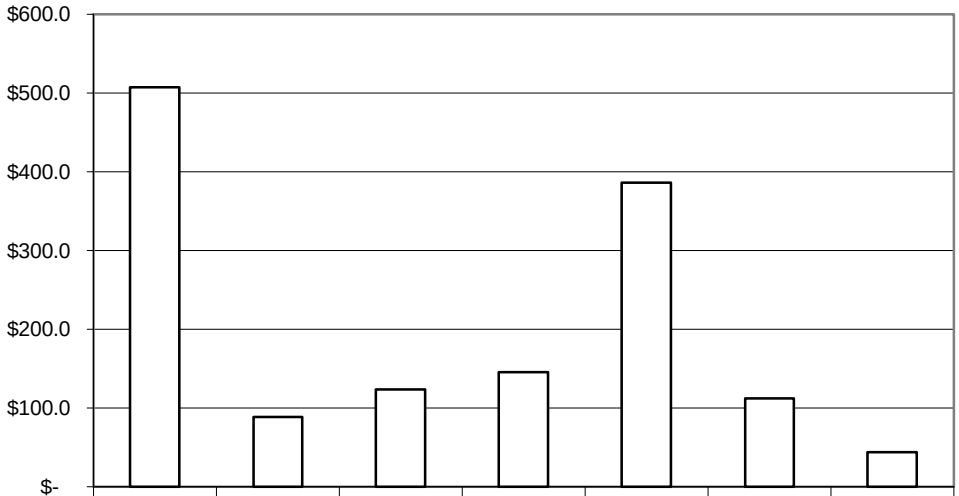
Figure 3 summarises typical end user costs experienced in our case study countries for a variety of usage patterns, showing the percentage due to ISP charges (the remainder being telco call charges and telco rental[11]). There is much variability both within and between countries. In order to make comparisons between countries, we compared costs for the 20-hour-a month local dial-up user, as this is within the range of the data that we do have, and similar OECD figures are available.

[11] Attachment 2 provides a bar chart for each country, showing the telco components.



	Cambodia	India	Nepal	S Africa	Uganda	Zambia	OECD
ISP charges	$62.4	$3.5	$13.0	$10.6	$50.0	$25.0	$9.4
Telephone Call Charges	$24.0	$10.2	$6.0	$31.5	$52.4	$25.3	$15.1
Telephone Line Rental	$10.0	$4.0	$2.0	$10.4	$5.8	$1.3	$12.2

Figure 4 End user costs in US$ for all 6 case study countries plus OECD
20 hours' peak time usage (showing breakdown into ISP and telco components)



	Cambodia	India	Nepal	S Africa	Uganda	Zambia	OECD
Total	$507.4	$88.9	$123.5	$145.8	$386.3	$112.2	$44.1

Figure 5 End user costs in US$ PPP for all 6 case study countries plus OECD
20 hours' peak time usage (breakdown not shown)

Our overall findings on costs for end users are as follows:

The cost of Internet access varied considerably among the case study countries, generally being lower in the larger and more competitive countries – India and South Africa.

In US $ terms, many users with local call access are paying prices that one might normally see in rich, developed countries. This is true in India and South Africa, which gives grounds to expect price reductions also in the LDCs[12] as their markets grow and ISP competition becomes effective.

Business users with leased circuits are paying highly for the privilege, especially in Cambodia. This reflects historically high levels of charges for domestic leased circuits and the continuing telco domestic fixed network monopolies.

Dial-up users outside main cities often have to pay for connected time at long distance call rates. Before tariff rebalancing, such rates can be very high (and this element of end user cost is likely to dominate the user's bill). This is true in all four LDCs.

In US$ terms, cybercafé prices are rather low by developed country standards. This is achieved by high utilisation of shared resources, even with some high input costs.

ISP costs generally account for under half of end user costs, with telephone company charges (especially for higher users) comprising the greater portion.

Relatively low prices for local use in Nepal (and to a lesser extent Zambia) partly reflect very low rentals and low call charges, which may rise with liberalisation and rebalancing.

Some of these findings are encouraging. However we also note that:

Users must also provide expensive terminal equipment such as a personal computer (PC), often paying above world prices because of import taxes and distribution costs[13].

Because of much lower incomes, even these lower price levels are still hard for the great majority of people to afford. Figure 5 illustrates this effect using a purchasing power parity (PPP) adjustment.

[12] Four of our case study countries (Cambodia, Nepal, Uganda and Zambia) fall into the United Nations Least Developed Country (LDC) category.

[13] We estimate that the cost of a dedicated PC would add around $65 a month to end-user Internet access costs. However, the PC would normally also be used for other applications.

Average usage times tend to be low in countries with high usage-based charging components.

Even with reasonable unit pricing, especially in the LDCs, total bills tend to be much higher than would be expected given the actual activities carried out on-line, because of poor network quality, leading to long down times, multiple call attempts per successful connection, and unduly long connection times to complete specific tasks.

In many places, service is not yet available at all, at any price; or only after a long wait.

3.1.2 The breakdown of end user costs

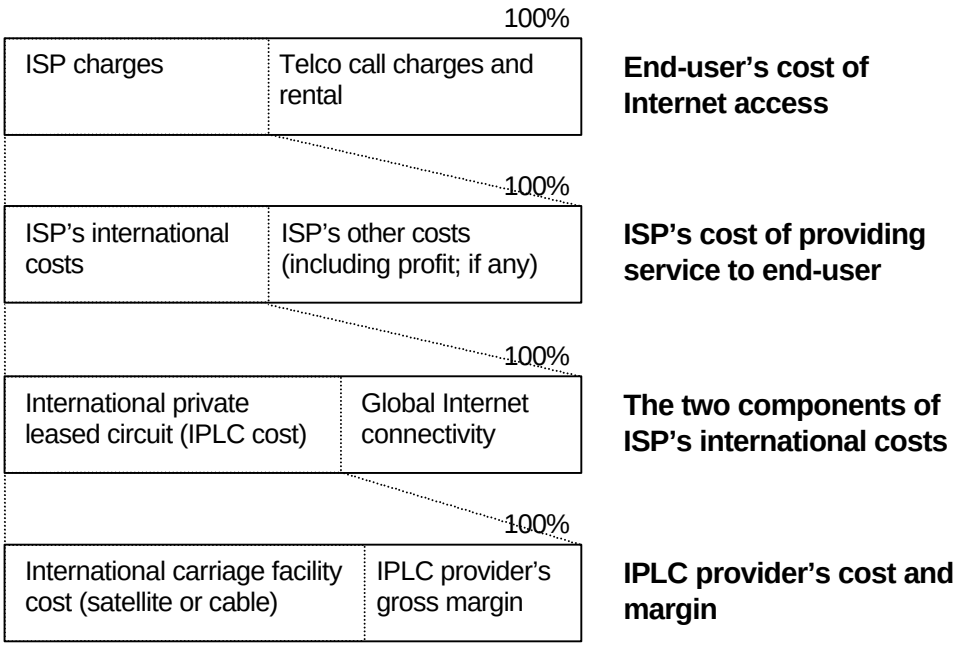


Figure 6 Breakdown of end-user Internet access costs to show international component

The study aimed especially to clarify the size and source of the international component of end-user costs. Figure 6 illustrates our simplified approach to this complex issue. No significance should be read into where the bars have been divided – the diagram is purely schematic. Only four layers are shown here (end user, ISP, IPLC provider and international carriage provider) but in practice other parties are usually involved (such as top-tier ISPs in South Africa).

Using this simplified approach, for each case study country we estimate the average cost of the international component to dial-up end users, by

multiplying percentages[14]. The results are shown in Figure 7. The figures are only indicative, because of the many assumptions involved, including:

the distribution and average level of actual usage;

a uniform reliance on international facilities by users of different kinds. This is not the case – for example, an hour of web browsing makes much heavier use of international bandwidth than an hour of email; one source suggests that they differ by a factor of 5.

The indications are that only in Cambodia, of our case study countries, does the international component currently represent a major influence on the total costs of Internet access to end users. However it is important to note from Figure 8 that at current costs, relatively small amounts of bandwidth per account are being supplied. Lower unit costs to ISPs should result in more bandwidth and better service.

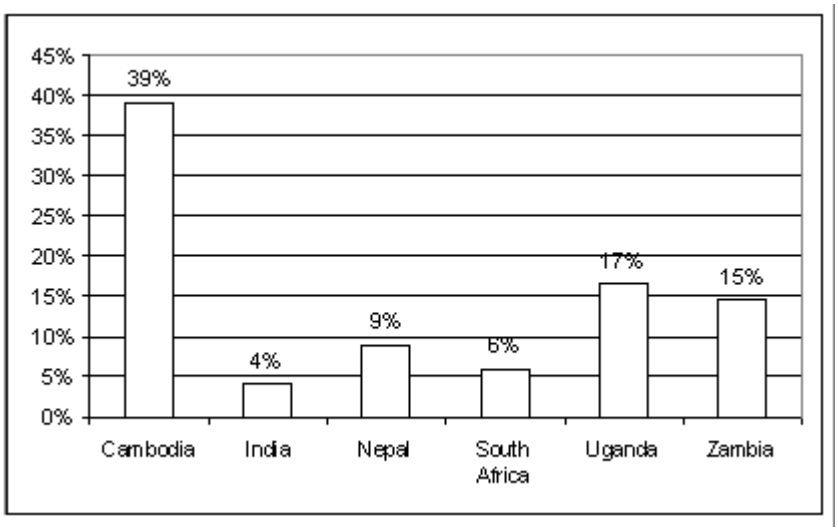


Figure 7 Estimated average percentages of dial-up end-user Internet access prices paid for international cost component in the case study countries

In the previous section we have already discussed how end-user costs are split between charges paid to the ISP and those paid to the telco. We now comment in turn on the remaining different boxes in Figure 6, reading from top to bottom and left to right.

[14] The percentage of end users' costs paid to the ISP, as shown in Figure 3 (taking a weighted average of the different usage patterns), times the percentage of ISP costs attributable to international bandwidth, as shown in Figure 8.

ISP's international costs The level of these in the case study countries is discussed in section 3.2.

ISP's other costs (including profit, if any) There is competition among ISPs in all our case study countries. Their non-international costs (such as skilled staff, accommodation, domestic telecoms, and equipment) are fairly standard. ISPs are not making excess profits – indeed they are more likely to be barely staying in business or to be subsidising their basic access offering from other, more profitable activities.

IPLCs and global Internet connectivity We discuss in 3.2 and 3.3 how these two conceptually separate items are often bought as a bundled package. Our studies showed that purchasers themselves are often not aware of the separate components, or of the possibility of purchasing them separately.

Global Internet connectivity The studies also showed that the cost of global Internet connectivity is usually quite low compared with the IPLC cost, and that the conditions of its supply at large hubs are competitive. This is discussed further in 3.2 and 3.3. We have not attempted any further breakdown of this cost component.

IPLCs The case studies identified these as the major source of international cost, and also of potential cost savings. More detail is given in 3.2 and 3.3 and in Attachment 4.

International carriage facility cost As an additional work module, we investigated the capacity prices being paid generally to satellite and cable providers for international carriage. Specific data in this market place are strongly protected by confidentiality restraints and we can currently only report in the general terms shown in Figure 8.

IPLC provider's gross margin As is shown in Figure 8, in most of our case study countries ISPs are paying within or close to a "normal" range for their international bandwidth. The high variability of satellite capacity prices precludes any further general statement at this stage on providers' margins. However, supplementary analysis using assumptions about input costs (see 3.2.3) showed high gross margins for incumbent telcos in the case study countries.

3.2 The international component of ISP costs

	Total international bandwidth[15]	Average price (US $ 000 per Mbps)	International as % of ISP total costs (average)	International kbps per account
Cambodia	2 Mbps	40	80%	0.6
India	1 Gbps	2.6	19%	0.2
Nepal	10 Mbps	10	24%	0.4
South Africa	260 Mbps	7	22%	0.4
Uganda	5 Mbps	20	30%	0.4
Zambia	5 Mbps	16	25%	0.5
Typical US/UK cable		2.5	<10%	>1[16]
Typical satellite		5-15		

Figure 8 International component of ISP costs
(Source: study estimates)[17]

Figure 8[18] shows that the prices paid for and proportion of ISP costs attributable to the international component vary greatly. However Cambodia stands out as exceptional with by far the highest prices, which represent 80% of the ISP's costs. In the other case study countries, this percentage is around 20% to 30%.

[15] In the case of asymmetric bandwidth to and from the country, the larger figure is used (normally that to the country).
[16] Based on a planning assumption of 8kbps per simultaneous user, and assuming an average use of at least 1 hour a working day (with 8-hour working days).
[17] All the figures in the table are estimates based on limited evidence. Please note that the results for Cambodia and Uganda are based on extrapolation from information supplied by a single ISP.

[18] Figure 8 estimates representative results for each case study country based on information relating to individual ISPs in that country. More detail of the data used is provided in Attachment 2 (

Figure 12), which in turn summarises information from the case study reports. Some additional confidential data are also reflected in Figure 8.

The amount of international bandwidth provided per account is low in all our countries by developed world standards, especially considering that a much higher proportion of each hour's use will be occupying international bandwidth. This exacerbates the well-known problems of slow access and downloading from the developing world.

3.2.1 Factors influencing cost of international component

The following factors contribute to the differences in prices paid:

The total size of the national market for international transmission, which determines whether or not it is commercially attractive to provide cable to that country. South Africa and India do have access to fibre optic cable, while the four LDCs all depend on satellites for international Internet transmission.

The amount of bandwidth which an individual ISP buys. In South Africa, for example, economies of scale are achieved by the tiered structure of the ISP industry, with a few international providers reselling international capacity to smaller domestic operators.

How open the international capacity market is, and how long it has been that way. All four LDCs now permit ISPs to buy satellite capacity directly on the open market, but in Cambodia this has only been the case for a few months. In Nepal it has been true for over two years, which have seen capacity halving in price. India has just opened the international capacity market, and South Africa plans to do so next year (but only to one additional operator).

The general attractiveness of the country's investment environment. Political stability and favourable tax regimes will attract foreign investment (where it is permitted) even to smaller markets.

The historic level of international leased circuit prices at the onset of competition. We discuss this further below.

Any business relationship between international capacity providers and ISPs within a country, especially where there are few of each. We believe that this is significant in Cambodia, where the ISP on which we have information is owned by the incumbent operator and is paying high leased circuit prices for half of its international capacity.

How well informed the ISPs in the country are about the options open to them. Satellite Internet access is being offered by many providers,

but they are not necessarily actively marketing their services in all the countries within their coverage[19].

3.2.2 Bundled purchasing and the role of the incumbent telco

As mentioned above, the international component (international Internet access) again has two main components, which may be purchased separately or (more often) packaged together, the international leased circuit and the global Internet connectivity. These constitute two distinct markets. We discuss this in more detail below and in section 3.3.

Of these two cost elements, the first is clearly dominant. It can easily account for 90% of the total. Historically, this payment was normally made to, and its level largely determined by, the incumbent monopoly telephone company. Where competition is limited or still young, prices tend to follow the lead set by the incumbent.

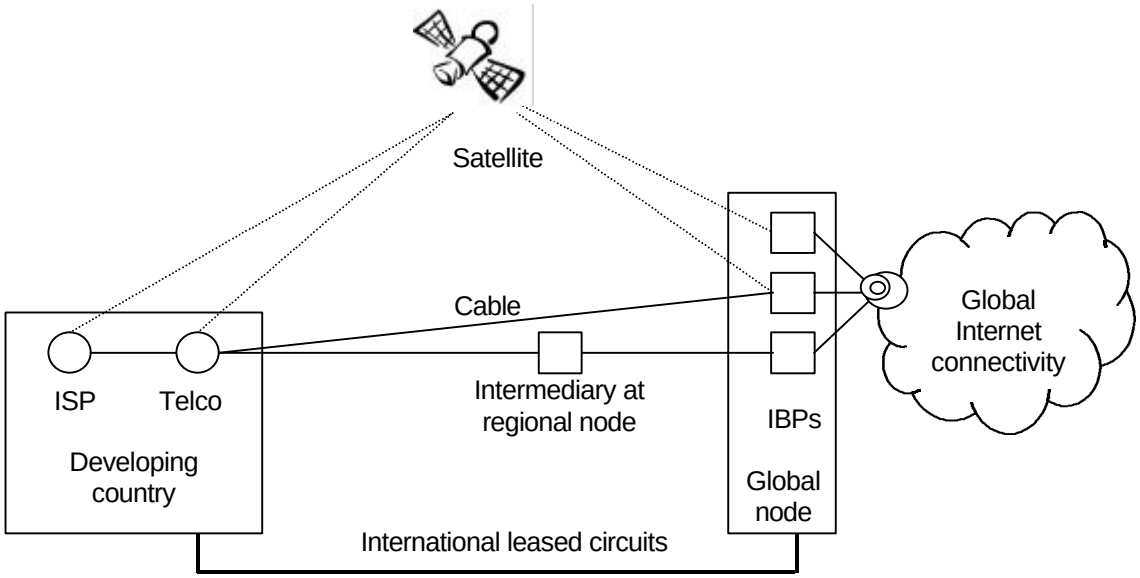


Figure 9 International Internet access options for developing country ISPs

The purchasing avenues that are open to ISPs, and the intermediaries involved in each, are of key importance. Figure 9 illustrates how in principle, a wide choice among competing providers of global Internet connectivity is available to a purchaser who has brought his stream of

[19] The satellite Internet connectivity market is very dynamic at present. As is seen in the last row of Figure 8, prices vary widely, reflecting differences in technology, specific scope and quality of service, contract term and other factors.

data by an international private leased circuit (provided over either cable or satellite) to a suitable global node[20]. Alternatively, in principle, the same purchaser might look at connecting into the global Internet at a regional node closer to home, where choice among IBP offerings could be less but savings might be achievable on the link to the hub.

In the worst case, an ISP in a developing country may have no option but to buy a bundled package of international leased circuits and global Internet connectivity from the incumbent telephone company[21]. These companies, with the full support of their governments[22], have traditionally priced international leased circuits at a high multiple of cost. This has been justified by the argument that the customers are businesses who can afford these high prices, and who are thereby contributing to low prices for residential users[23].

A more potent reason is the fear that businesses with international leased circuits may (even if illegally) resell the capacity, undercutting the incumbent's international call prices and diverting its revenues. We discuss this in more detail in Attachment 4.

Another potential problem is that the far-end (for example, US) half-circuit prices may not be as low as they would be on a route with competition at both ends, or with higher total demand. With bundled purchasing of leased circuits (that is, one-stop shopping for both half-circuits), such discrimination would be easy to disguise. We believe that this possibility merits closer examination, and discuss it further in Attachment 4.

A first step in expanding ISPs' options is to permit the sale of both-way satellite bandwidth direct to them. This can have an immediate dramatic effect on incumbent prices. For example, Nepal Telephone Company's 1998/9 Annual Report states "NTC has slashed the tariff for the international leased circuits by over 50% to face the competitive environments such as licensing of VSATs by Nepal Telecom Authority".

[20] See, for example, the IBP listings at http://www.ispworld.com/isp/bb/Backbone_Profiles.htm. The best-served global hubs are in the USA, although others such as London, Frankfurt or Tokyo also offer considerable choice.

[21] Telecom companies are typically permitted to lease international cable capacity on more advantageous terms than ISPs. They may acquire Indefeasible Rights of Use (IRUs) (equivalent to long-term leases on cable capacity) or get low Administrative Lease rates for shorter term requirements. However there is little incentive for them to pass the savings on.

[22] Who often find a single monopoly telephone company a comfortable source of tax revenues as well as of telecoms services that they need not pay for.

However, with limited competition there will also be a natural tendency for prices to hover around a level which "the market will bear" but which is still far above achievable costs[24].

3.2.3 Incumbent telco gross margin analysis

Based on the information available to us about the costs faced by telcos in developing countries from international carriers, we have estimated the gross margin which incumbent telcos in the following countries could earn from the supply of International leased circuits, and where relevant, global Internet connectivity.

Country	Estimated telco gross margin on international Internet connectivity
Cambodia	72%
Nepal	49%
South Africa	63%
Uganda	56%
Zambia	74%

Especially where the amounts of money spent by the ISPs with the telcos are very high (and they are nearly $800,000 per month in the case of UUNet in South Africa), these gross margin figures appear excessive.

To take a specific case, Telkom South Africa has been quoted to us as charging CITEC $97,800 per month for 4Mb/s capacity. We estimate Telkom's out payments to other carriers at $27,215 per month in respect of this service. This leaves Telkom with an estimated gross margin of $70,585 per month for this service (72% gross margin). Telkom's local costs not covered above include the cost of a 4Mb/s local circuit, admin and billing charges. Together these costs are unlikely to amount to more than $5,000 per month at most, including amortisation of the capital employed.

We therefore conclude that Telkom is making a very substantial supra-normal profit on its provision of international connectivity to ISPs. Similar statements could probably be made about the incumbent carriers in the other countries just mentioned. However, it appears in general that the

[23] A similar argument has applied to international calls. However, unlike international calls, international leased lines rarely account for a large proportion of total revenues, and accordingly any cross-subsidy flowing from them has relatively minor effects.

[24] This problem has dogged Europe for years. See for example Recommendation C(1999) 3863 on leased circuit interconnection pricing. A survey and analysis by the International Telecoms Users' Group suggests that in Europe it is difficult to cost-justify international leased-line prices being more than 30% above domestic leased line prices (see http://www.intug.net/surveys/ill/explanation.html)

only ISPs that are actually buying their international connectivity from the incumbents are those with no choice or under an incumbent's direct control.

3.3 The market for international Internet access

As already mentioned, we see the market for international Internet access in developing countries as having two main components[25], which were illustrated in Figure 9:

> The **international leased circuit** between the developing country and a Network Access Point (NAP) on an Internet backbone network in a developed country[26]. For our case study countries, this NAP is normally located in the US or Canada, although ISPs in some developing countries connect in Europe or in developed parts of Asia.
>
> The **global Internet connectivity**[27] provided by the connection at the node in the developed country between the international leased circuit and the Internet backbone network.

On the evidence of the case studies, it seems clear that the competitive conditions are quite different for these two main components of international Internet access. Until very recently, international leased circuits were generally provided by a monopolist, at least at the developing country end. An early step in liberalisation, already taken in all our case study countries except South Africa, is to permit competition in international leased circuits used for data only. Though welcome, this step has not yet led to much competition, as such a restricted market is obviously of much less interest to potential entrants than the full international market, including voice, would be.

However, ISPs from developing countries appears to have some choice among IBPs in the developed countries, so long as the ISPs satisfy technical interconnection requirements. Moreover it appears that the developing country ISP would be able to change quite quickly the developed country ISP with which it connects. Once contractual requirements about notice are satisfied, the necessary changes could be made in a matter of hours in an Internet exchange, for example. However, the relatively low bandwidth required by an individual ISP obviously

[25] In addition, local ends to an international leased circuit may need to be purchased separately, adding significant extra costs and also complexity to the purchasing process.
[26] Usually, but not necessarily, at an Internet Exchange.
[27] We use the term "global internet connectivity" in this over view report to mean the same as the term "paying transit", used in Appendix G, since the latter is more likely to be confused with the very different idea of transit in telephony

means that the more attractive prices offered at high bandwidths are not available; it may also mean that there is little active sales effort directed towards developing country ISPs.

Are international leased circuits monopolised at the developing country end as the result of market failure? In our view, the position is as follows:

> The monopoly over the provision of international leased circuits in many developing countries is the result of a statutory prohibition on competition. This may originally have been intended to support a policy of tariffing some telecommunications services at below cost, or to assure that the telco continued as a source of funds to Government. Certainly it would not be possible to lift the prohibition on competition without considering the implications for tariff rebalancing and other policy questions.
>
> If the prohibition on competition in international leased circuits were lifted, the result might not be a great deal of competition, since potential competitors will be deterred by the small size of many developing country markets.

We did not find any evidence of exploitative behaviour by companies from the developed countries, either in the international leased circuit market or in the global Internet connectivity market. On the whole, the developing country ISPs to whom we talked did not seem very concerned about the possibility of this kind of exploitation. Other factors, such as the monopoly of the telecommunications company in their own country, the lack of revenue sharing on telephone calls to ISPs, and the potential for unfair competition by the ISP operation of the monopoly telco, were of far greater concern.

It is also notable that most of our interviewees were unwilling to disclose their detailed costs for international access. This could be interpreted in various ways, including having signed non-disclosure agreements and/or a fear of retaliation by powerful suppliers. In the current context we feel it means (at least in part) that they did not want to share the secrets of success.

We therefore do not see conditions in the international Internet access market as being due to market failure at the developed country end. As discussed below, exploitation or some other kind of market failure could arise, but we have no evidence of this at the moment.

3.3.1 Remedies for market failure

Appendix G explains that, given that the global Internet connectivity market is dominated by a few large companies, exploitative behaviour by dominant backbones over IP routes (or "strings") where backbone market power is concentrated, together with discriminatory charging at Network Access Points, remains a distinct future possibility, and one that would be extremely damaging to small ISPs (not just those in developing countries). Two approaches to this potential problem may be considered:

Try to pre-empt it by increasing the transparency of peering and transit agreements, introducing regulatory assessment of levels for cost-based tariffs, and requiring these tariffs to be made available to all ISPs on a non-discriminatory basis.

Develop avenues for redress that would be effective in the event of its arising.

4 Additional findings

4.1 Evidence from elsewhere

The picture presented above is mainly built on the findings from our six case study countries. It has been reinforced by various items of information from other Asian and African countries, found through our review of ITU case studies, literature review, previous experience and personal contacts. Some of this additional information is reproduced in Appendix H.

It is perhaps not surprising, given the small size of our sample, that we have not been able to see any significant regional differences between Africa and Asia. As commented above, the main differences appear to be between the more and less developed countries in the sample, cutting across the regional distinction. In principle, there could be advantage to some Asian developing countries from being relatively close to world cities such as Singapore, Hong Kong and Tokyo. On the other hand, more African than Asian countries can (and do) benefit from being within a shared satellite footprint with the United States.

A recent study of Internet provision in Latin America[28] echoes many of our comments in relation to the smaller and poorer countries of the region. However, continuing rapid growth in bandwidth and falling prices to the larger and richer countries also give grounds for optimism.

Pacific and APEC countries

We have been fortunate to see the results of a parallel study on Internet access costs carried out for the Pacific Islands Forum Secretariat. While this study did not share our focus on the international component of costs, it provides additional valuable information on end-user costs derived from a special Pacific Islands survey, as well as from APEC countries. Section 3 of Appendix H summarises data derived from this source[29].

We see that end-users in small, poor Pacific countries (mostly with under 1m population and per capita GDP under $5,000) are paying twice as much as end-users in APEC developing countries, and three times as much as end-users in APEC industrialised countries, for 10 hours of dial-

[28] Survey and research of the Internet arrangements and the development of Internet connectivity in and across Latin America - a report to Regulatel – AHCIET.

[29] Pacific Islands Forum Secretariat survey, unpublished, 2000, supplemented from standard statistical sources.

up use. However the discrepancies for leased circuit users are much greater than this, involving factors of 4 and 64 respectively.

The picture is entirely consistent with our findings. The report recommends liberalisation of Internet service provision and a review of the regulatory regime in telecommunications, so as to encourage the use of new technologies appropriate to the necessarily small scale of operations in these countries.

4.2 Cost-sharing and the APEC principles debate

Following the APEC Cancun Ministerial Statement in the spring of 2000, there has been extensive international debate of the principle of "appropriate mutual compensation" for the use of Internet resources. Relevant work continues in various public industry fora, and of course in closed commercial circles. The review carried out for this study naturally drew mainly on the former. Our main findings are that:

The most vocal proponents of mandated cost-sharing have been the relatively developed Asian economies, plus Australia. All are vying to become major Internet traffic hubs. They see sharing the costs of international connections as a necessary step towards putting their cost bases on a more even footing with those of the USA.

The less developed Asian economies recognise that they would not have much to gain from traffic-based cost-sharing, at any rate in the short term, because the direction of traffic is strongly unbalanced towards them[30]. Voice over Internet, if introduced, could change this picture.

Activities surrounding this issue seem to have shifted from debate towards practical implementation. Public statements by all parties increasingly focus on the role of commercial negotiators in advancing interconnection arrangements. The proposed role of central authorities seems to have shrunk to one of possible competition law enforcement, should infringements be found.

As is discussed in Appendix G, traffic-based interconnect charging is likely to be introduced within the next few years between major operators for certain services for commercial reasons (for example, global mobile roaming and voice over IP). This is not a trivial step, as it entails measuring traffic and assessing its type, source, and/or

[30] As the biggest part of the traffic is Web pages downloaded from the USA to the developing country.

destination. Once implemented, these techniques may also be applicable to general Internet traffic exchange.

We were asked to comment on the likely outcome of widespread adoption of the APEC principles[31]. Taking the principles to mean directional traffic-based sharing of the cost of international links, our comments are:

The idea of directional traffic-based cost-sharing is that each party should bear those costs for which they are responsible. But this model would only be valid between parts of the world with similar levels of Internet development, for example between the USA and Australia or Europe. The developing country ISPs in our study host much of their content in North America[32], and route much of their domestic or regional traffic via North America. This means that a high proportion of the traffic in both directions is instigated by, and is for the benefit of, the developing country.

The high prices of international private leased circuits (IPLCs) in many countries are at the heart of the problem. If both half-circuits were priced at similar levels, it might seem more reasonable to request cost-sharing – but the need for it would also be less.

Several commentators have suggested that reductions in the cost of links to the USA without at least corresponding reductions elsewhere would further reinforce the position of the USA as the global Internet hub. Others however see it as essential to their own economies' chances of competitiveness that US ISPs should bear their share of international infrastructure costs. These two types of effect are opposed, but both could be valid and significant to different parties, for example depending on whether they aim to compete in local or global markets.

In short, it seems that the APEC proposals were neither primarily designed to benefit developing countries, nor likely soon to have been very beneficial to them. They have raised the political profile of the mutual compensation issue, which is now likely to be taken forward on a commercial rather than a mandated basis.

[31] The APEC proposals led to ITU discussions about recommendation D.50. Both are reproduced for convenience in Appendix M. Given the diluted wording of D.50, this seems a hypothetical question. The actual APEC principles however live on, in a commercial rather than regulatory incarnation.

[32] They do this because hosting skills are to be found in North America, and hosting services there are reasonably priced, as well as because of the high prices and scarcity of regional links. In addition, a substantial proportion of requests for web content often come from expatriates.

5 Policy options to lower costs

Market and technical developments are already lowering the cost of Internet access. This chapter outlines a range of policy options which could help to make this happen faster, in particular by exerting downward pressure on excessive IPLC margins.

But even in the most favourable conditions, we should not assume that the Internet would soon become universally affordable. The fundamental problem in the four LDCs studied is extreme poverty, coupled with only moderate population, leading to small market size. From the examples of Cambodia and Uganda, we see that liberalisation does not automatically lower prices unless the market is attractive in other respects. Small markets are disadvantaged in several ways:

- They cannot benefit from the economies of scale and scope which are so characteristic of large telecoms networks;
- They have no chance of indigenous manufacture, and are obliged to buy equipment on world markets with little bargaining power;
- Equipment running costs may also be raised by a lack of local maintenance capability;
- Outside investment will find many more attractive alternatives.

These factors point to network costs remaining high by world standards. Geographic factors (such as Nepal's mountains and Zambia's sparse population), and lack of other necessary infrastructure such as a reliable electricity supply, also make for high costs of provision.

Poor people in LDCs may therefore remain for many years without convenient or affordable Internet access. In any case they may be unable to benefit directly from it, for example because of a lack of content in their own language. They should however indirectly benefit considerably from wider availability of the Internet in their countries, through positive effects on (for example) the economy, employment, and education.

The sections which follow explore options for direct action to reduce the cost of Internet access. These are complementary to other actions aimed at growing Internet use, which we do not discuss here. Both approaches are necessary. By combining them, a virtuous circle can be created

whereby lower costs encourage more use which in turn further lowers costs.

5.1 Liberalisation within developing countries

The policy imperative to liberalise telecommunications supply within developing countries is already widely accepted[33]. Some developing country governments however are not yet convinced of this, while others face difficulties implementing such policies. Developed country governments, often acting through international agencies, can usefully help to persuade the former and support the latter.

For bringing down Internet access prices, the priority markets to liberalise[34] are:

International leased circuits

Domestic leased circuits

Long distance calls

VSAT connections

Internet telephony

Liberalisation of the first three (traditionally profitable) markets often means the withdrawal of cross-subsidies to the traditionally loss-making markets of local access and calls, with consequent price rises. In recent years Internet use has reduced the need for such "**rebalancing**" price rises (as lost revenues are recouped from additional Internet use, up to the limits permitted by network capacity). In parallel, technology advances are also lowering the cost of access. However, in our view moderate local price rises, if necessary, are usually worth paying for the benefits of liberalisation[35].

Permitting private **VSAT** connections with both-way transmission will probably permit major cost reductions for leased circuit customers, especially as new lower-cost satellite offerings become available. Regulatory supervision of incumbents' IPLC prices, to avoid excess profits, may well also be necessary for an extended period.

[33] For more detail on appropriate approaches, see for example "*What telecom regulation for low-income African countries?*" October 2000, report by BIPE for the European Commission, available at http://europa.eu.int/ISPO/intcoop/i_acp.html

[34] Or (where there is a lack of potential entrants) at least commercialise, so as to improve the incumbent's performance.

[35] Some countries may want to consider special price plans for low users, who suffer the highest price rises through rebalancing.

Liberalising **Internet telephony**[36] could be particularly beneficial for both ISPs and users, though often initially unwelcome to incumbents. It would provide extra traffic to ISPs who choose to offer telephony, enabling economies of scale and eventually lower Internet access costs to be achieved, as well as cheaper phone calls for end users. In our view liberalisation of Internet telephony would soon generate more than enough additional traffic to compensate the incumbent for any lost revenues.

Complaints are common that the ISP run by the main telco has **unfair advantages** over all other ISPs. This is normally already contrary to regulations, but these may need strengthening, and regulators may need support in enforcing strict separation of ISP from incumbent telco operations. Structural separation may well be the better course.

Several of our case studies have commented on the high level or inappropriate structure of **licence fees** (for example, turnover-based levies). It is a generally accepted principle that licence fees should be set at most to cover necessary regulatory costs[37]. It is out of keeping with the aims of liberalisation to use them as a source of government revenues. To keep end-users charges down, the lowest possible licence fees are desirable for all Internet players, and especially for telecentres which serve multiple users[38].

5.2 Revenue-sharing between carriers and ISPs

Considerable benefits may flow from the provision of special numbers for dial-up Internet access, charged at uniform rates throughout the entire country[39]:

> Most obviously, usage costs for rural or remote users would be put on a more equal footing with those for urban users.
>
> Given the current huge predominance of urban users, it should be possible to fix these rates only slightly above current local rates without overall revenue loss.
>
> The distinctive numbers enable dial-up Internet traffic to be routed separately from ordinary telephone traffic, which in turn enables the

[36] We use the term to mean a phone-to-phone service accessed by dialling a prefix and carried over the Internet.
[37] This does not apply to permissions to use scarce resources like spectrum or telephone numbers.
[38] In some countries, however, the tax system may be rather inefficient, so that efficiency in the economy overall may actually be better if revenue is raised through telecoms licence fees than through the tax system.
[39] Such numbers in the UK usually start with 0845.

quality of service provided to each traffic stream to be determined and protected separately.

The special charging arrangements for these numbers open the door to a variety of new commercial deals between the local telephone company and ISPs[40], and in turn between ISPs and end users. One of these is the "free ISP" model pioneered by Freeserve in the UK. Because of its partial reliance on advertising revenues, this particular model may well not succeed in low-income markets (indeed, its future is questioned elsewhere). However there are many variants which could succeed.

The revenue sharing model came into being in the United Kingdom as a result of competition between terminating operators for ISPs' business. While it could be introduced by a single incumbent telco, competition would undoubtedly lead to more varied and dynamic offerings. This would be another benefit of fixed network liberalisation.

It is worth noting that many ISPs in the case study countries, as well as elsewhere in the world, regard basic service provision as a commodity business, with ancillary activities such as web hosting or proxy server provision becoming their major sources of profit. Because margins have become so slim, there is a move towards requiring **payment for content.** This could turn into a major new barrier for users in developing countries. Some publishers of learned journals are now offering special discount rates for web access to their content from developing countries, and such moves must be welcomed[41].

5.3 Making better use of bandwidth

Another approach to reducing international bandwidth costs (or improving quality of service to users) is to avoid unnecessary long-distance routings. Two particular initiatives of this kind have arisen in our case study countries:

Setting up local Internet exchange points (IXPs) so that ISPs can exchange national traffic locally. A suitable colocation point is a prerequisite for an IXP; in many countries this may be at the incumbent's international gateway exchange, where all ISPs' circuits converge for onward transmission. A parallel recent report for DFID

[40] Normally including an element of "revenue sharing", that is, the telephone company passing a percentage of the relevant call revenues on to the ISP, via a terminating operator where that is distinct from itself.

[41] Although many would argue that learned journals are already overpriced even for developed world customers, and that the academic community should use the potential of the Internet to bypass established journal publishers.

explores the IXP option fully for Africa. Similar initiatives are being progressed at the regional level in Asia[42].

More local hosting of locally originated content aimed at the national audience, and caching of frequently accessed foreign content. These expedients are both being adopted already, especially in India and South Africa.

It is also worth remembering that the United States offers a relatively open business environment of which others can take advantage. For example, a consortium of developing country ISPs could set up a company in the US to get better interconnection rates by consolidating bandwidth requirements.

5.4 New and alternative technologies[43]

Cellular mobile telephones are making a significant contribution to the overall accessibility of telephone service in all our case study countries, most notably in Cambodia, which holds the world record in this respect (90% of all telephones being mobile). Some argue that expenditure on mobiles reduces the amount of money that people can spend on Internet access. However, we see the rise of mobile on balance as positive for the Internet.

Already in many countries mobile text messaging is a popular alternative and complement to email, and extension of this capability to a full **mobile email** service (probably in the context of a network upgrade to allow General Packet Radio Service (GPRS) is an obvious next step.

A **cheap, robust terminal** designed specifically for email over mobile networks seems bound to be a commercial success in many developing countries. Because email uses only a low bandwidth and tolerates delay, email-by-wireless service for otherwise unserved remote locations[44] could be a way of getting them some communications capability relatively cheaply; however this may not be commercially viable in the short term.

[42] See http://www2.itu.or.th/peering/; an Asia-Pacific Internet Interconnection Forum took place in June 2001 under ITU auspices.
[43] See, for example, the Final Report of the ITU Focus Group on New Technologies for Rural Applications (available February 2001 at http://www7.itu.int/ itudfg7) and continuing work of the relevant Task Force.
[44] Along the lines of the pioneering VITASAT experiment - see http://www.vita.org/leo/vitasat.htm

Different approaches to provision of **low-cost Internet terminals**[45] are already attracting significant attention, and are worth widespread support.

On a different tack, modern website design, with effects such as moving graphics, requires increasing bandwidth for satisfactory results. Parallel to the "Bobby" scheme for websites that are accessible to users with impaired vision[46] could be **a new kitemark** for websites designed to meet the needs of users with low bandwidth connections. Mobile Internet access using Wireless Application Protocol (WAP) has already prompted many popular web sites to have "light", wireless-ready sites, and if WAP achieves a wide takeup then doubtless many more will follow.

When achieving narrowband Internet access is a major challenge, it may seem pointless to aim for **broadband access**. However, there are good reasons for developing countries to plan to provide broadband Internet access, at least in major population centres:

Independent infrastructure (for example, cable television or split lines using Digital Subscriber Line (DSL) technology) would ease the extra burden imposed on telephone networks in carrying Internet traffic.

Widespread interest in (and benefit from) the Internet may well rely on entertainment-led services of reasonable quality. The example of India, where cable television is expected to lead growth, is worth noting.

Good quality Internet access could help stem the brain drain.

As is recognised in South Africa, broadband is necessary for the full potential benefits of distance education and distance healthcare to be realised.

In Attachment 5 we discuss the challenge posed by **the transition to IPv6.** There is an opportunity here for rich countries to support the developing world, in particular by:

Advising developing country ISPs on appropriate timing and mechanisms for the transition;

Ensuring that developing countries get a fair share of IPv4 address space for as long as they need it.

[45] For example, the Indian simputer development (http://www.simputer.org), modified games consoles and recycling of used PCs from rich countries.

[46] And potentially supported by the same Web Access Initiative. See http://www.w3.org/WAI/References/access-brief.html

5.5 International markets

Our study has shown that there are different views on how the international regulatory framework affecting Internet interconnection can, or should be, interpreted. In coming years there will be continuing opportunities to ensure that this framework evolves in ways that meet the needs of developing countries. Fair deals for smaller players, and appropriate **grievance procedures**, are of particular importance. Constant vigilance is necessary to ensure that changing market structures do not lead to anticompetitive practices on the part of powerful participants.

One option that arose in our study is that NRAs should begin to get to grips with the **cost structures** involved in international Internet interconnect, in order better to be able to assess the prices charged. In parallel, they might consider requiring greater **transparency of pricing**, at least to regulators if not to the broader public. Doubtless the industry would wish to avoid any requirements of this kind, which they might best do by demonstrating voluntarily that prices are reasonable and transparent.

Our studies suggested that developing country ISPs are not always aware of the full range of international connectivity options open to them. Evaluating these options, which can be quite complex, is already a significant burden. There is a clear opportunity here for **awareness and consultancy services** to improve how well the market works. The international community can play a useful role by initiating and possibly subsidising such services. Similar services could also help policy-makers to improve their understanding of the structure and functioning of this marketplace and to keep abreast of change.

Attachment 1: Acknowledgments

This report is an output of a study commissioned by the UK Department for International Development, in consultation with the Department of Trade and Industry. The following, all of whom are collaborating independent consultants, comprise the core project team:

Hugh Collins, Michael Dixon, Nicholas Garthwaite, Alison Gillwald, Tessa Groves, John Hunter, Mike Jensen, Rohan Kariyawasam, Wyn Lucas, Claire Milne, Chirag Unadkat, Arno Wirzenius

In addition, the following have made important contributions to the study.

In direct support of the core project team:

Valerie Aitken, Bob Franklin, Antony Milne, Gordon Oyomno, Dominic Pinto, Irma Verwey, Christine Williams

By supplying information and views:

Bram Dov Abramson of Telegeography
Shyam Agrawal of Worldlink in Nepal
Ganesh Kumar Bangah of MOL Cybercafés in Malaysia
Djilali Benamrane of UNDP in Niger
Dai Davies of DANTE
Timothy Denton of T M Denton Consultants
Martin Dodge of University College London
Robert Guild of the Pacific Islands Forum Secretariat
K K Gunawardana, Tim Kelly and Ben Petrazzini of the ITU
Mark Holland of Ovum
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Robert Milne of Nortel Networks
Sean Moroney of AITEC
Sam Paltridge of OECD
Alejandro Pisanty of CUAED in Mexico
Christophe Quentel of Ministère des Affaires Etrangères, France
George Scharffenberger of Volunteers in Technical Assistance
Russell Southwood of Balancing Act
Roger Stanyard of DTT Consulting

Most of all we are indebted to the many people in our case study countries who agreed to be interviewed and helped in other ways. These are named (where appropriate) in the relevant case study reports.

Attachment 2: Tables of case study findings

Country Indicators	Cambodia	India	Nepal	South Africa	Uganda	Zambia
Population	13.1 million (2000)	> 1 billion (2000)	21.8 million (1998)	43.7 million (2000)	23.3 million (2000)	10.5 million (2000)
Population below 14 years	Below 12 years 42%	34%	41%	32%	Below 16 years 10 million	48%
Population in capital area	9%	27% urban		55% urban	10%est	
Population below poverty line	36%	35%	42%	25%	55%	86%
Area (000 sq km)	181	3,288	141	1,220	236	753
Neighbours	Thailand, Laos, Vietnam	Pakistan, China, Nepal, Bhutan, Burma, Bangladesh	India, China	Namibia, Botswana, Zimbabwe, Mozambique, Swaziland, Lesotho	Sudan, Kenya, Tanzania, Rwanda, Congo	Angola, Republic of the Congo, Malawi, Mozambique, Namibia, Tanzania, Zimbabwe
Life expectancy	57 years	63 years	58 years	51 years	43 years	37 years
Religion	Theravada Buddhist 95%	Hindu 80%, Muslim 14%	Hindu 90%	Christian 68%, indigenous beliefs and animist 28.5%	Roman Catholic 33%, Protestant 33%, Muslim 16%	Christian 50%-75%, Muslim and Hindu 24%-49%
Literacy	35%	52%	27%	82%	62%	80%
Government	Multiparty liberal democracy (1993)	Federal republic	Parliamentary democracy	Republic	Republic	Republic, multi-party
GDP (ITU)	$ 2 bn / year (1999)	$427 bn / year (1998)	$5 bn / year (1999)	$130 bn / year (1999)	$6 bn /year (1998)	$4 bn / year (1997)
Annual GDP / capita (ITU)	$175 (1999)	$435 (1998)	$222 (1999)	$2,969 (1999)	$284 (1998)	$463 (1997)

Country Indicators	Cambodia	India	Nepal	South Africa	Uganda	Zambia
GDP structure	Agriculture 43 %, industry 20 %, services 37 %	Agriculture 25 %, industry 30 %, services 45 %	Agriculture 41%, industry 22%, services 37%	Agriculture 5% industry 35% services 60%	Agriculture 44%, industry 17%, services 39%	Agriculture 21 %, industry 31 %, services 48 %
State budget	Revenue $327 m (1999), expenditures $393 m (1999)	Revenue $35.8 bn; expenditures $66.3 bn, incl capital expenditures $15.9 bn (FY98/99 est.)	Revenues $536 m, expenditures $818 million	Revenues $30.5 bn, expenditures $38 bn	Revenues $959 mn, expenditures $1,004 mn	Revenue $606 m(1999), expenditure $547 m (1998 est.)
Economic aid	$427 million	$3 billion	$411 million	$676 million	$840 million	$2 billion (1995)
GNI per capita (Worldbank, 1999)	$260	$440	$220	$3,170	$320	$330
GNI per capita (Worldbank, 1999) valued at PPP	$1,350	$2,230	$1,280	$8,710	$1,160	$720
Currency	1 new riel (CR) = 100 sen	Rupee	Nepalese rupees	Rand	Ugandan shilling	Kwacha
Exchange rate (May 2001)	3,800 to US$	47 to US$	69 to US$	8 to US$	1,525.8 to US$	3,000 to US$
Exch rate: PPP	0.19	0.20	0.17	0.36	0.28	0.46

Figure 10 General statistical indicators for the case study countries

Sources: Trade partners UK (http://www.tradepartners.gov.uk/index.html)
CIA World Factbook 2000 (http://www.cia.gov/cia/publications/factbook/)
DFID Internet costs project: Country case study reports
Worldbank: world development indicators database (http://www.worldbank.org/data/databytopic/GNPPC.pdf)

Telecommunications Indicators	Cambodia	India	Nepal	South Africa	Uganda	Zambia
Fixed main lines	29,000	32,436,100	266,900	5,492,800	350,000	83,100
% of last in capital area	55%		64%	60% est		
Main lines per 100 inhabitants	0.3	3.2	1.2	12.5	1.6	0.9
Waiting list		2.7m (1997)	289,586	None (1999)	8,954 (1998)	25,000 (1997)
Payphones	303 (1999)		1200+	173,000	1333 (1998)	513 (1997)
International voice circuits	479 (1999)	17,922	877 (1999)	8,000 (1996)	282 (1998)	167 (1998)
International O/G voice million minutes	7.3 (1999)	436 (1998)	25 (1999)	405 (1998)	6.4 (1998)	13 (1997)
International I/C voice million minutes	24.1 (1999)	1,499 (1998)	23 (1999)	450 (1997)	17.9 (1998)	17 (1997)
Main telecom operator – staff	731 (1999)	427,000 (1998)	5,219	49,128 (2001)	1,890 (1999)	3,260 (1997) (Zamtel)
Main telecom operator – lines/staff			51	112		24 (1997) (Zamtel)
International voice traffic open to competition	no	no	no	no	no	no
No. of international voice operators	1	1	1	1	1	1
Int'l data leased ccts open for self-provision / resale	Yes, yes	Yes, yes	Yes, yes	No, no	Yes, yes	Yes, no
No. of international data leased circuit operators	2	1 (only just liberalised)	6 est	1	8	3

Telecommunications Indicators	Cambodia	India	Nepal	South Africa	Uganda	Zambia
Domestic fixed networks open to competition	No	Yes	No	No (second licence 2002)	Yes	No
No. of domestic fixed network operators	3 (in separate areas)	40 (2 in each of 20 circles)	1	1	2	1
Mobile networks open to competition	Yes	Yes	Yes	Yes	Yes	Yes
No. of mobile network operators	4	40 (2 in each of 20 circles)	1	2 (soon to be 3)	3	3
Mobile connections k	240	3,577	11	8,900 (2000)	56	90
Mobiles per 100 population	1.0	0.4	0.04	12.0 17 (2000)	0.3	1.0
ISPs	4	300+	12	75	7	3
Internet Hosts	479	35,810	1,101	187,649	171	892
Internet accounts	7,000	1,400,000	11,000	750,000	9,000	5,000
Internet users (ITU)	6,000	10,000,000	100,000	2,000,000	80,000	15,000
Internet users per 10,000 inhabitants	5	49	22	549	12	17
TV per 100 inhabitants	0.7	6.9	0.7-4.6	12.5	2.5	8 (1997)
Personal Computers per 100 inhabitants	0.1	2.7	0.3	6.2	0.3	0.7

Figure 11 Telecommunications indicators for the case study countries

Sources: Internet Hosts: Internet Software Consortium (http://www.isc.org/) January 2001 count
ITU Telecommunication Indicators (http://www.itu.int/ti/industryoverview/index.htm)
AISI Connect On-line Database (http://www2.sn.apc.org/africa/)
DFID Internet costs project: Country case study reports

International capacity					Key Indicators			Notes
Country/ISP	**Link details**	**Bandwidth**	**Cost to ISP $/month)**	**% of ISP expenditure**	**$/Mbps**	**Number of accounts**	**Kbps/ account**	
Cambodia								
Camnet (MPTC's subsidiary)	Via MPTC Leased line to Singapore	512 kbps	27,000	80%	52,734	1,700	0.60	These are MPTC's retail prices
	Via VSAT to Hong Kong	512 kbps	13,500		26,367			
India								
VSNL	IOCOM Cable (Chennai – Penang); Gulf Cable (Mumbai – Fujirah); SEA-ME-WE-2; SEA-ME-WE-3; FLAG; SAFE; ANTRIX (VSAT); ICO Global; Intelsat; New Skies Satellite N. V.; Inmarsat; Iridium	1 Gbps (December 2000). Estimated 13 Gbps by 2004.	Not available			1.4 million	0.75 on average (assuming that the VSNL total of 1 Gbps is serving 1.4 million internet accounts in India)	All Indian ISPs now use VSNL as the int'l Internet gateway. ISP's NOW and Satyam have already established gateways and more are being set up. VSNL says it costs INR 7.5 m to build a 2 Mbps link to USA .
Typical ISP	Via VSNL	2 Mbps	5,320	19%	2,598	10,000	0.21	

International capacity					Key Indicators			Notes
Country/ISP	**Link details**	**Bandwidth**	**Cost to ISP $/month)**	**% of ISP expenditure**	**$/Mbps**	**Number of accounts**	**Kbps/ account**	
Nepal								
NTC	Satellite capacity provided by Intelsat; fibre link Denmark-US) and Internet connectivity provided by Teleglobe	2 Mbps down; 2 Mbps up				1300	1.5 down; 1.5 up	NTC internet gateway tariff (sell on to ISPs) is $34,286 per 2 Mbps per month
Mercantile	Satellite capacity and Internet connectivity provided by Singapore Telecom	5 Mbps down; 2 Mbps up				1347	3.7 down; 1.5 up	
Worldlink	Satellite capacity provided by JCSAT; internet connectivity provided by Loral Cyberstar	3 Mbps down; 1.5 Mbps up	225,000 est	20-30%	5,000	6000	0.5 down; 0.25 up	
Computerland	Via Mercantile	304 kbps dn; 32 kbps up				887	0.34 dn; 0.04 up	
Himalayan Online	Via Mercantile	128 kbps dn; 128 kbps up				190	0.67 dn; 0.67 up	
Infocom	Via C&C	240 kbps dn; 64 kbps up				500	0.5 dn; 0.13 up	

International capacity					Key Indicators			Notes
Country/ISP	**Link details**	**Bandwidth**	**Cost to ISP $/month)**	**% of ISP expenditure**	**$/Mbps**	**Number of accounts**	**Kbps/ account**	
Everest Net	Via Mercantile	128 kbps dn; 64 kbps up				373	0.3 dn; 0.15 up	
South Africa								
CITEC	London and Middle East	4Mbps	97,800 est.	35%	24,500			Other ISPs inS Africa connect with these top tier ISPs, buying bundled international connectivity.
Internet Solutions	New York	81 Mbps	567,000 est.	25%	7,000			
UUNET	Boston and New York	133 Mbps	798,000 est.	20%	6,000			
SAIX	New York, London	42.5 Mbps	255,000 est.	20%	6,000			
Total South Africa		260.5 Mbps				750,000	0.36	
Uganda								
Infocom	Satellite to USA	1 Mbps (est)	27,000	30% est.	13,500	5,000	0.82	
	Satellite to Netherlands	1 Mbps (est)						
Zambia								
Typical ISP	Typical ISP		16,000	25% est.				

Figure 12 ISPs' international connections and costs in the case study countries

Breakdown of Internet user costs: General Notes

1) The OECD methodology was followed where possible.

2) The cost of the personal computer, other hardware and software is excluded

3) Telephone line rental is the monthly line rental for a residential user.

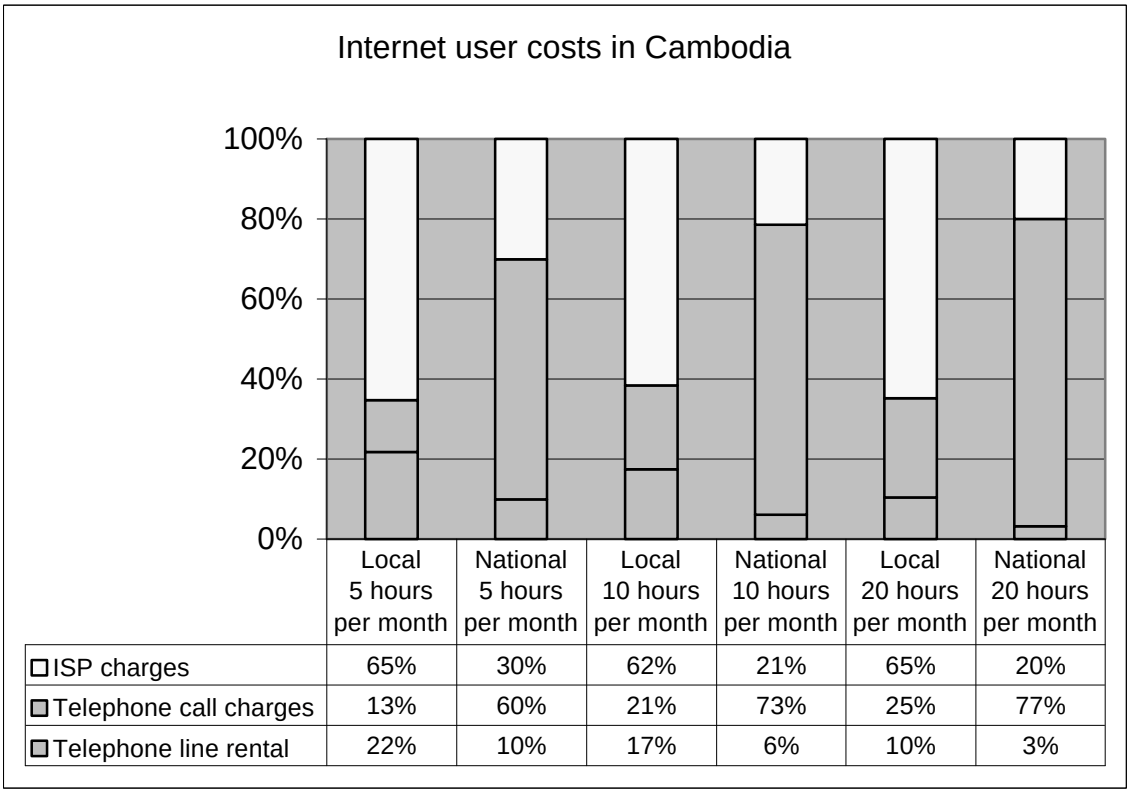
4) Initial connection or installation charges are excluded

5) ISP charge is the monthly ISP charge from one of the bigger ISPs offering service

6) For local access (e.g. in urban areas), call charges are the local call tariff, at peak times (in cases where a peak tariff exists)

7) For national access to an ISP (e.g. in rural areas), local call rates are not always available.

8) Tax is included where applicable.



	Local 5 hours per month	National 5 hours per month	Local 10 hours per month	National 10 hours per month	Local 20 hours per month	National 20 hours per month
ISP charges	65%	30%	62%	21%	65%	20%
Telephone call charges	13%	60%	21%	73%	25%	77%
Telephone line rental	22%	10%	17%	6%	10%	3%

Figure 13 Breakdown of Internet user costs in Cambodia

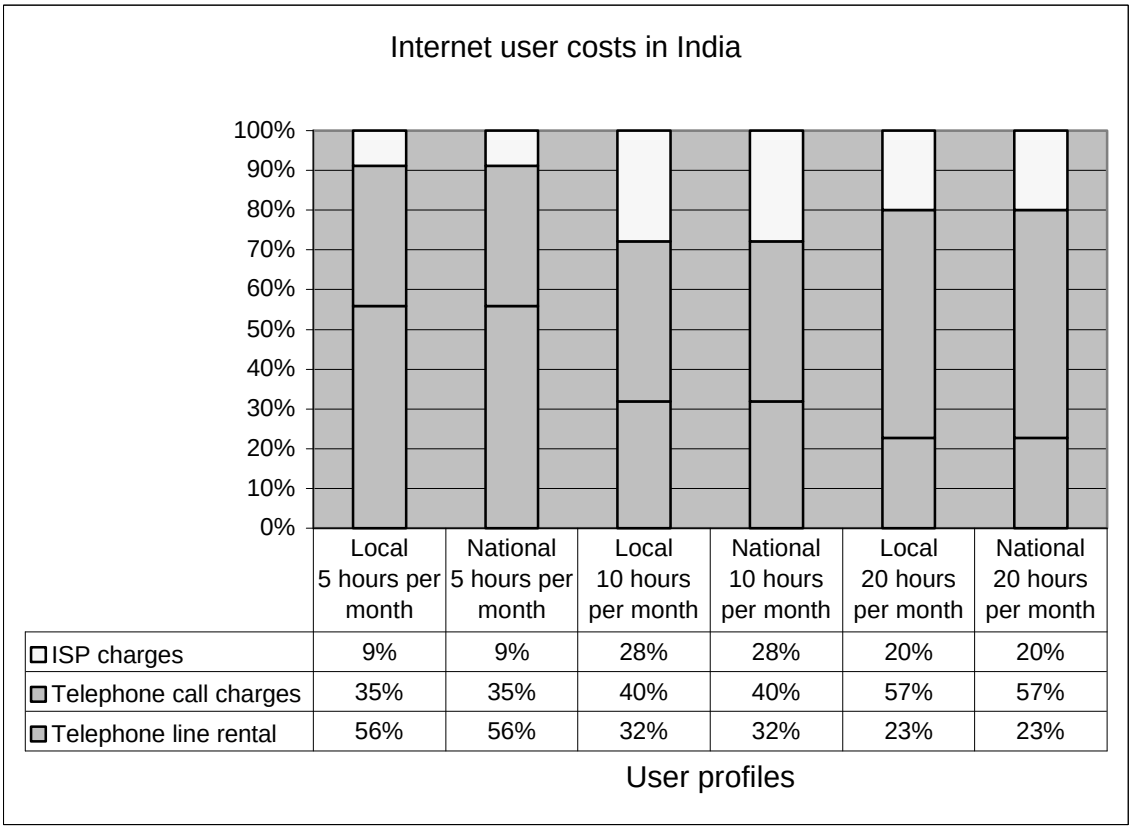


Figure 14 Breakdown of Internet user costs in India

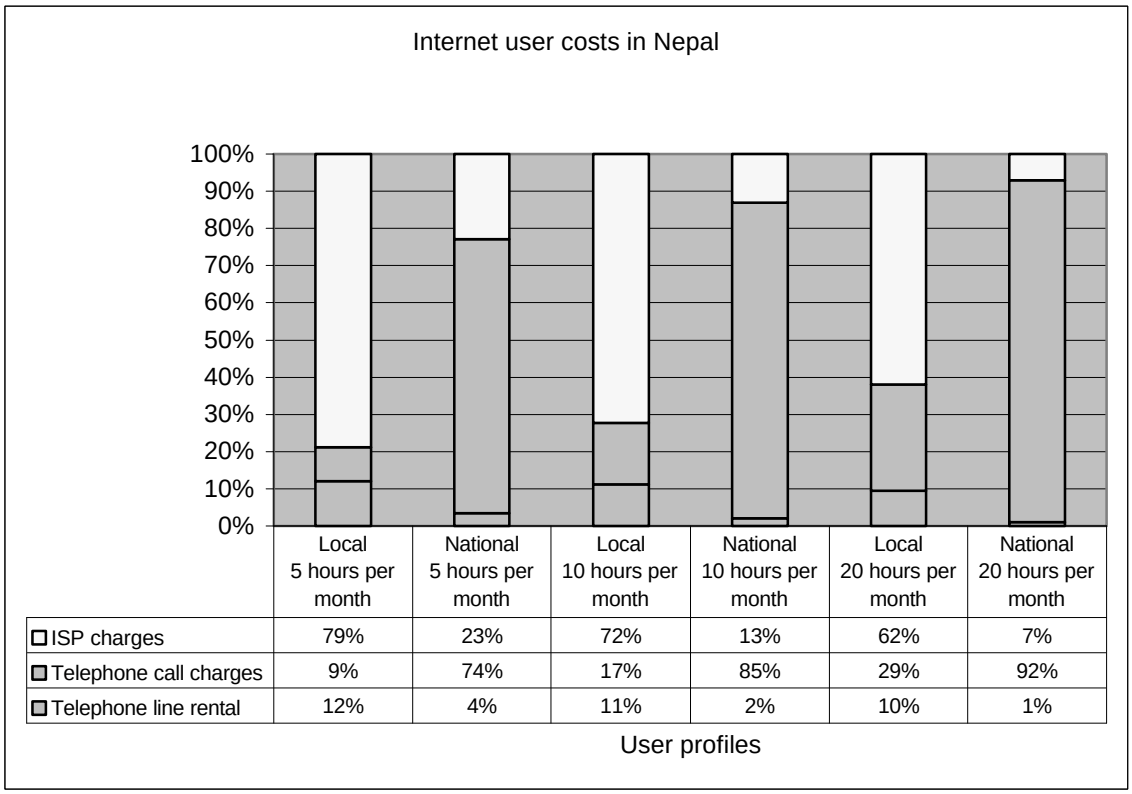


Figure 15 Breakdown of Internet user costs in Nepal

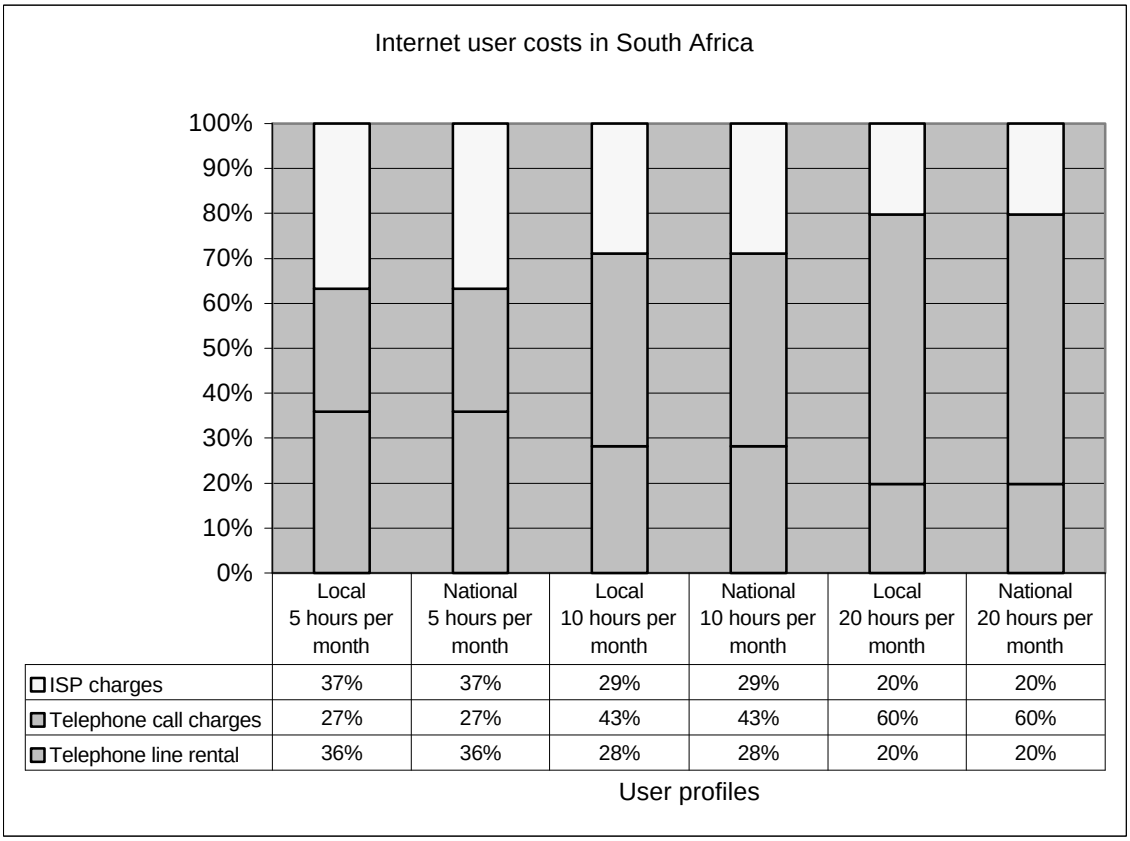


Figure 16 Breakdown of Internet user costs in South Africa

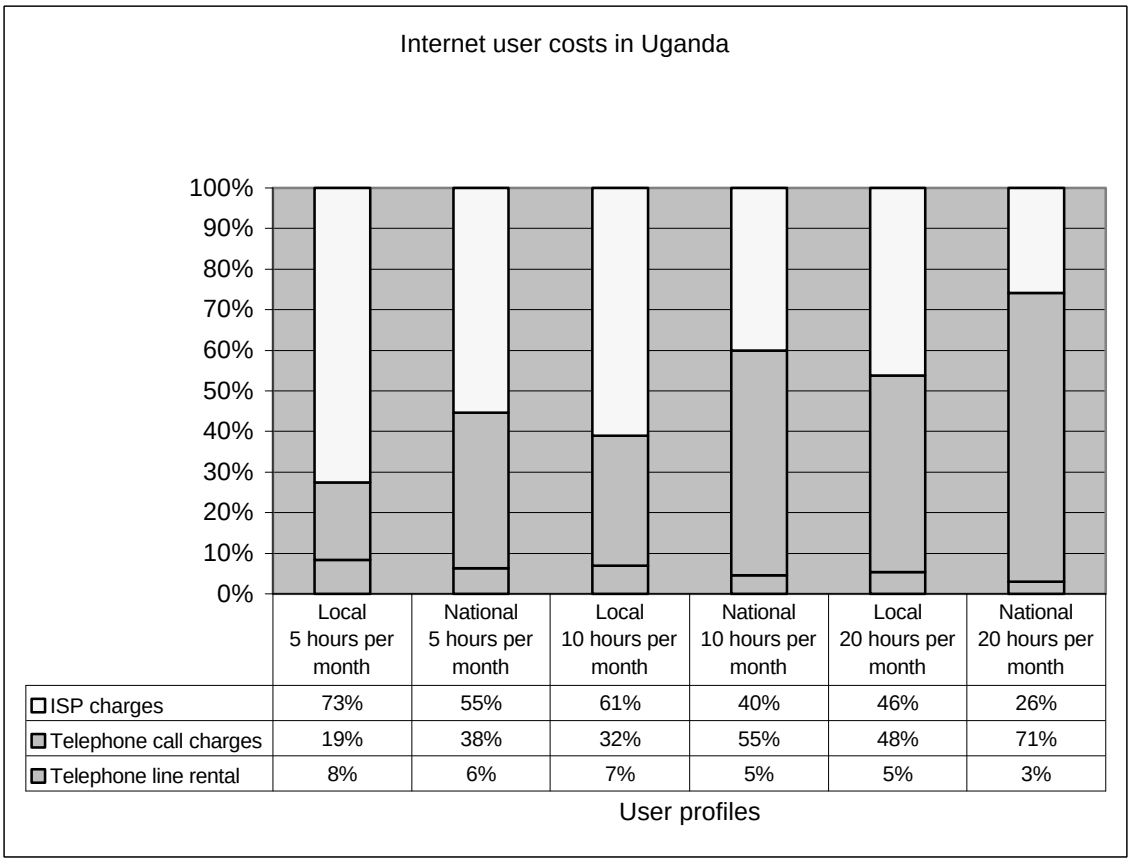


Figure 17 Breakdown of Internet user costs in Uganda

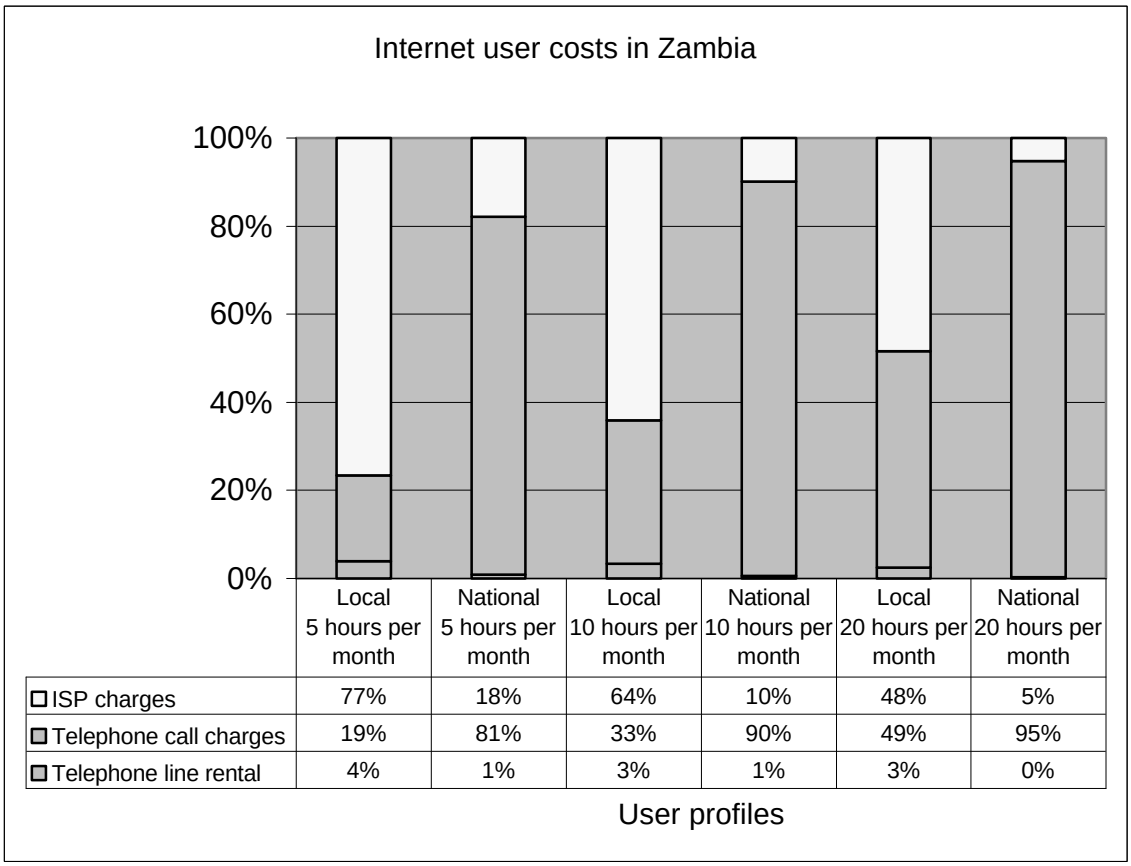


Figure 18 Breakdown of Internet user costs in Zambia

Attachment 3: Summaries of country case studies

Attachment 2 summarises key indicators and findings in tabular form. Below we discuss major quantitative and qualitative findings for each country in turn. Appendices A to F are the full case study reports.

A3.1 Cambodia

Cambodia is a very poor country, emerging from a civil war. The lack of fixed network and the corresponding small number of fixed telephone lines make Internet access complicated. In 2000 there was one Internet account per 5 fixed telephone lines (a very high proportion, indicating that the number of telephone lines is limiting Internet expansion) and 0.25 fixed lines per 100 inhabitants (which is very low). A major concern is extension of Internet services outside the capital region. The poor quality of the network limits modem access speeds to less than 30 kbps. The number of mobile phones is nine times the number of fixed phones, but Internet access using mobile phones is slow and expensive.

Camnet is one of four licensed ISPs. Camnet's bandwidth for international Internet connectivity is presently 1 Mbps. This is small by current international standards, which means they have little bargaining power. The cost of this bandwidth is around 80% of Camnet's total costs. Global Internet connectivity is included in the price for the international leased circuit as a "free extra", which means that its real price is not known to the purchaser.

The government uses high tariffs for international leased circuits as a source of cash. Very Small Aperture Terminal (VSAT) access supplied by competitors is priced accordingly.

The situation is a vicious circle: high charges for international leased circuits result in low demand. Low demand results in little interest in investing in international high capacity optical fibre connections. This lack of interest results in higher underlying costs and slow turnaround time on satellite circuits, leading to low quality and high charges.

To extend local Internet access, rather strong measures are probably needed:

Major expansion of the fixed telephony network (possibly involving privatisation of the state telco);

Major investments in wireless dedicated Internet access; and / or

Successful major introduction of mobile data communications.

A3.2 India

In 2001 there are estimated to be about 26 million fixed telephone lines, up from 23 million in two years, giving an overall teledensity of 2.6%. About 20% of these lines are in four major cities; overall there is a heavy weighting to the west of the country (especially Maharashtra and Gujarat). The number of mobile lines is catching up with the number of fixed lines. About 85,000 km of optical cable has been laid down, and there are plans for a further 15,000 km.

Internet penetration in India is relatively high for a country of its income level, at 1%, with 10 million people connected to the Internet using an estimated 1.4 million distinct Internet accounts. Penetration is expected to exceed 8% by 2005. The vast majority of Internet subscriptions are among the 27% of the population who live in urban areas. Most towns have a local Point of Presence (POP) for connection to the Internet. Most national ISPs also publish a single national number for connecting to the Internet at local call rates even from towns where there is no local POP.

The incumbent monopoly ISP was not allowed to operate all over the country in the early part of Internet history to allow other ISPs to gain a foothold. This has led to healthy competition amongst the 100+ ISPs and very competitive pricing for Internet access. Recent further liberalisation means there are now few or no serious regulatory barriers to setting up an ISP business or establishing an international gateway. New entrants are expected to set up competing gateways soon. The average ISP is losing money, but this will change if average Internet usage per customer doubles its current level of 52 minutes a day.

ISP prices for the end users have gone down from around US $ 0.75 per hour in 1995 to US $ 0.04 per hour at present. There are several “free” ISPs and 56 kbps dial-up unlimited use monthly plans range from US $ 2.50 per month to US $ 4.50 per month. Telco charges are payable over and above these ISP charges, and local call charges are the biggest variable cost component for Internet access. Overall, the average effective cost of Internet access to the dial-up user is US $ 0.81 per hour taking account of network inefficiencies.

The cost of PCs has been the single largest deterrent to Internet penetration in the country. An entry level new PC costs about three times the average per capita annual income. Low telephone penetration (2.6 per 100 inhabitants) has been the other factor hindering the growth of the Internet in India.

Internet access using cable television links is expected to get around local call charges, low PC penetration and low teledensity. It is already available to users at around US $20 per month for a 64 kbps permanently connected ('always on') link with no other charges. Around 10 million new Internet users are expected to be generated via cable connections, leading to 55% of all Internet users connecting via cable within a year and more than 70% by 2005. This rapid volume growth is expected to lead to much lower prices.

Overall India uses more than 1 Gbps of international Internet bandwidth. Bandwidth growth is at par with the growth in subscriber base. The cost of international bandwidth represents less than 20% of the total costs of a typical 10,000-customer ISP.

There is one prominent International Gateway company, with reasonable bargaining power in the international bandwidth market due to its volume of business, equity participation in bandwidth projects and board level positions in these projects.

However, much of this bandwidth could be better used. The bulk of "Indian" web sites are not in India. This gives rise to a lot of international Internet traffic that could be retained within the country. The country's largest ISP is creating local caches or proxy servers of frequently visited sites to reduce the need for international bandwidth.

International bandwidth is also used for email and chat (which together account for more than half the total time spent by Indians on the Internet), as most "Indian" email and chat accounts are located outside India.

Initiatives for improvement already under way include:

Reduction in domestic leased circuit prices, particularly to encourage the spread of cybercafés.

Liberalisation of terminal and switching equipment imports.

Upgrading of the cable television network to support bidirectional links.

A3.3 Nepal

The incumbent NTC currently serves 270,000 fixed telephone lines, with a waiting list of nearly 290,000. The waiting time has been brought down to an average of eight years, although this hides the worse reality in many areas. Similarly the averaged penetration (1.6% in 2000) disguises the fact that nearly 170,000 (62%) of the lines are in Kathmandu with almost all of the remainder in the other larger towns.

Lack of basic telephone infrastructure and the high cost of computers have limited Internet accounts to around 9,000, although this figure does not include visitors to Internet cafes or voice over Internet users. This represents 0.04% of the population, which is low even allowing for the poverty and poor education. Local call charges account for much of the cost of Internet traffic.

Internet use is limited by the lack of links between the ISPs in Nepal and between Nepal and the outside world. There are two local telephone links into India for local traders' use and some associated microwave links to India and to Bangladesh, but no fibre links out of Nepal. The ISPs mainly use low capacity VSAT links. However, for the time being the cost of the international links represents a small part of the overall cost of access.

Initiatives for improvement already under way include:

1) Upgrade of telephone exchanges
2) Provision of digital lines
3) Fibre links abroad
4) Revenue sharing number option for Internet access
5) Local linking of ISPs
6) Pooling of resources for negotiation

A3.4 South Africa

There are about 6 million fixed lines, provided by Telkom, which will lose its monopoly (to a duopoly) in 2002. The service is highly developed in the commercial centres but has very low penetration in rural and remote areas, especially in the former 'independent homelands'. The regulatory regime under which Telkom has operated was designed to improve on earlier, even lower, levels of penetration. Until the second operator is licensed, only Telkom provides international telecommunication links

(using both fibre links and satellites). There are more than 8 million mobile lines, provided by two operators.

At 4%, South Africa has the highest Internet per capita penetration in Africa. The South African Internet market comprises some 70 to 80 ISPs, with about 750,000 dialup subscribers and an estimated 1.8 million users. Four private top-level ISPs provide leased circuit Internet and dial-in POP services to second level ISPs and corporate users using the infrastructure of Telkom, which is also a competitor for both their dial-up and leased circuit Internet services. The top level ISPs provide international connectivity with bandwidth capacities ranging from 4Mbps to 133Mbps. Prices paid for international connectivity range from US $6,000 to US $25,000 per Mbps and represent between 20% and 35% of the ISPs' costs.

The Department of Communications is committed to expanding the concept of universal service to include enhanced services such as Internet access. It believes that affordable access will only provided in the short to medium term to underserved areas through state intervention. Plans include the creation of a broadband satellite network connecting all educational institutions in the country. This network will be exempted from current regulatory and tariff restrictions.

Dial-up users pay between US $ 10 and US $ 20 for unlimited Internet connectivity. These charges are exclusive of telephone charges, which they pay directly to Telkom and which are the major part of the bill. For example, a user paying US $ 17 a month for an Internet subscription will pay an additional US $ 42 to Telkom for 20 hours a month local call access at peak times, or US $ 15 at off peak times. A free ISP backed by one of the major banks (ABSA) has recently attracted a large number of subscribers, and although this may reduce the cost burden for some users, the local call charges are still likely to discourage use.

The ISPs were not willing to disclose detailed business costs on the ground that they constituted confidential information. Costs do include a VAN licence of US $ 2500 per year paid to the regulator (which is not seen as excessive) and connectivity charges paid to Telkom. These depend on the bandwidth capacity of the leased circuit and in some cases relative volumes of the local versus international traffic. Good technical expertise is relatively expensive, as it is scarce due to large numbers of skilled technicians leaving the country.

There is a general perception across the industry that Internet prices are four to five times higher than they are in comparable economies. There is also agreement that they could be brought down to international levels

through appropriate regulatory processes that open up the market to international competition and promote collective access strategies. It has been further suggested that the proposed opening of the fixed network market to a duopoly is unlikely to change current price levels significantly.

A3.5 Uganda

There are currently 350,000 fixed network telephone lines in Uganda provided by the incumbent UTL (representing a teledensity of 1.6). While fixed line rental at US $ 6.73 per month is fairly low, the price of dial-up calls is high at US $ 3.07/hour for local daytime and US $ 8.07/hour for national daytime calls. Network quality tends to be poor (up to 22kbps in Kampala, less in rural areas where local loops are long and cable joints are suspect). The number of mobile subscribers overtook the number of fixed lines in June 2000.

There are 13 licensed ISPs, with about 8,500 customers and over 80,000 individual users. There is a degree of competition in basic telecoms as well as in Internet service provision, but end-user costs of Internet access are high. The average user in Kampala pays a total of US $ 96 per month for 10 hours of full Internet access per month. Outside Kampala, the high cost of phone calls drives the cost up to US $146.

For the dial-up Internet customer living in Kampala, who requires full Internet access and spends the average 10 hours per month on-line, 18% of their total service cost can be ascribed to international bandwidth. This figure comes down to 6% for an urban e-mail only user spending 10 hours per month on-line. For heavy users at 30 hours per month on-line, the figure is as high as 33%.

For most users the cost of phone calls is significantly greater than this. For the dial-up Internet customer living in Kampala, who requires full Internet access and spends the average 10 hours per month on-line, 32% of their total service cost that can be ascribed to telephone call charges. For the rural market, the figure is significantly higher at 55%. There is a strong body of opinion that UTL should give a substantial discount to national calls that are made to ISP telephone numbers. A revenue sharing arrangement with UTL and/or MTN would allow the ISPs to reduce prices significantly and stimulate the Internet market.

A major concern for the existing ISPs is that UTL, and to a lesser extent MTN, will exploit their positions as major fixed and mobile network operators to favour their own ISP activity over those of the independent competitors. Given the dominance of inland call charges in ISP costs, this is a significant concern. There is a clear need for monitoring of the

situation by the regulator, and for regulatory intervention at least to force equal trading by the fixed and mobile network operators with all ISPs, whether owned or not. The regulator might need some transitional support to achieve this. A more radical and effective solution would be structural separation.

The Ugandan Internet exchange point (IXP) initiative is a contentious issue with established ISPs such as Infocom. For any established ISP the desire to establish revenue share with UTL and/or MTN is a much more important and immediate issue than a local Internet Exchange or lowering international bandwidth cost. However, we expect that both the volume of Internet traffic and the proportion of which is of national origin and destination will grow, so that for a new entrant ISP, a local Internet exchange will increasingly be a desirable feature.

Since July 2000, the regulator has stopped issuing new VSAT licences after protests from the telephone network operators alleging the illegal use of voice over IP by ISPs. There are currently 8 International Data Gateway (IDG) licence holders. ISPs without an IDG licence need to obtain international Internet access via one of the existing IDG licence holders. For some ISPs, therefore, international Internet access is a source of revenues as well as of costs.

A3.6 Zambia

There are only about 80,000 exchange lines in Zambia (0.9 per 100 inhabitants). Typical of traditional monopoly operations, exchange line rentals and, to a lesser extent, local calls are too cheap (at $1.30 per month and 2 US cents/minute) while national and international calls are too expensive (at up to 63 US cents/minute and up to $3 per minute).

There are two GSM mobile operators and an obsolete analogue mobile service, with altogether more mobile customers (90,000) than fixed network lines. Most mobiles are now pre-paid and call charges are about 40 US cents/minute. Both GSM operators are planning to become ISPs. A number of initiatives are taking place to try to improve telecommunications services in rural areas.

The telecommunications market is said to be open to competition except for international voice, where Zamtel retains a monopoly. Further liberalisation is linked to the delayed privatisation of Zamtel. Zamtel is not currently offering any new retail or wholesale services to support ISPs. Zamtel's ISP could be competing unfairly by being cross-subsidised as accounting information is not available.

As Zambia is a small country in telecoms terms and is landlocked, international telecommunications links use satellite. Lack of access to international fibre cables may become serious, as the demand for international capacity increases.

The Internet is much in evidence in Zambia. New industries such as growing roses and the export of vegetables rely on the Internet. Email addresses and web pages are included in publicity material. There are several Internet cafés. There are three ISPs, with in total about 10,000 customers: Zamnet, developed from the University; CopperNet, a management buy-out from the copper mines; and Zamtel itself. A dial-up account costs between $20 and $30 per month, and direct access costs about $500 per month.

An ISP licence costs $40,000 for five years plus 5% of revenue. ISPs are able to operate their own VSATs (providing international voice is not carried) and their own local access circuits. Each ISP uses satellite to access the Internet in the US or Canada. International bandwidth is up to 2Mbps for each ISP, and these costs are around one third of the ISP's total costs. Though high, the cost of international bandwidth is not a consuming issue in the scheme of things. It is available and it works. A simple model suggests that if the international bandwidth costs halved, ISP profits would double, or alternatively customers could get a cheaper or faster service.

To reduce the costs of the Internet:

Its value must be demonstrated to decision makers;

Zamtel needs to be put on a sound commercial footing with clear incentives for improved performance;

Practical assistance could be offered to the ISPs;

More Internet cafés are needed in the cities to improve coverage, and also in the rural areas, although this is more problematic; and

The possibility of cheap reliable terminals should be explored.

Attachment 4: International leased circuit pricing

The price of international leased circuits has proved to be a key issue for this study. This attachment therefore offers some further information on this topic:

Examples of pricing of satellite half-circuits by BT (representing rich countries) and developing countries.

An introduction to recent developments in international call pricing, with an outline of their relevance to the price of international leased circuits.

A4.1 Examples of international leased circuit pricing

UK to:	BT Half	Remote Half – Date
Angola	$30,000	$60,000 – 1999
India	$25,000	$50,000 – 2000
Mozambique	$30,000	$70,000 – 1999
Namibia	$30,000	$48,000 –1999
Pakistan	$30,000	$75,000 – 1998
Seychelles	$30,000	$128,000 – 1999
South Africa	$25,000	$40,000 – 1999
Sri Lanka	$30,000	$27,000 – 2000
Zambia	$30,000	$68,000 – 2001
	Source: BT Price List 2001	Source: Tarifica

Figure 19 Monthly Half Circuit Rental – Satellite 2 Mbps Retail

Figure 19 permits comparison of half-circuit prices between the UK and a selection of developing countries at various recent dates. It is clear that the "poor end" prices are significantly higher than their "rich end" counterparts for all countries except Sri Lanka. Sri Lanka Telecom is preparing to face international competition from August 2002.

The BT half circuit charges given above have come down by about 50% since 1997 as a consequence of regulation, competition, and re-balancing. Traditionally it was always believed that international services (calls and IPLCs) were very profitable. To support this we understand that the Intelsat price for a half circuit (ground station to satellite) is about $10,000 (and that both half circuits cost the same).

We have no information on the margins that telcos make on different routes within an IPLC business. It would not be surprising, however, if margins were below average on more competitive routes, and correspondingly above average on less competitive ones – which would include those to most smaller developing countries. In addition, the EU has amassed evidence of huge variation in IPLC prices within Europe[47], which suggests that some operators may be making excessive profits on IPLCs as a whole. Appendix G discusses available remedies in case anti-competitive pricing of IPLCs were to occur.

In most developing countries competitive pressures have still to be applied. As a consequence, with only a few exceptions, remote half circuit prices have not seen a similar reduction to those seen in the UK, and are about twice as expensive. A reduction in IPLC prices should follow from a rebalancing of prices to achieve more similar rates of return on different services. This will take time. An instant reduction would pose a similar threat as reduced international settlement rates, which we discuss in the next section.

A4.2 International telephone call and leased circuit prices

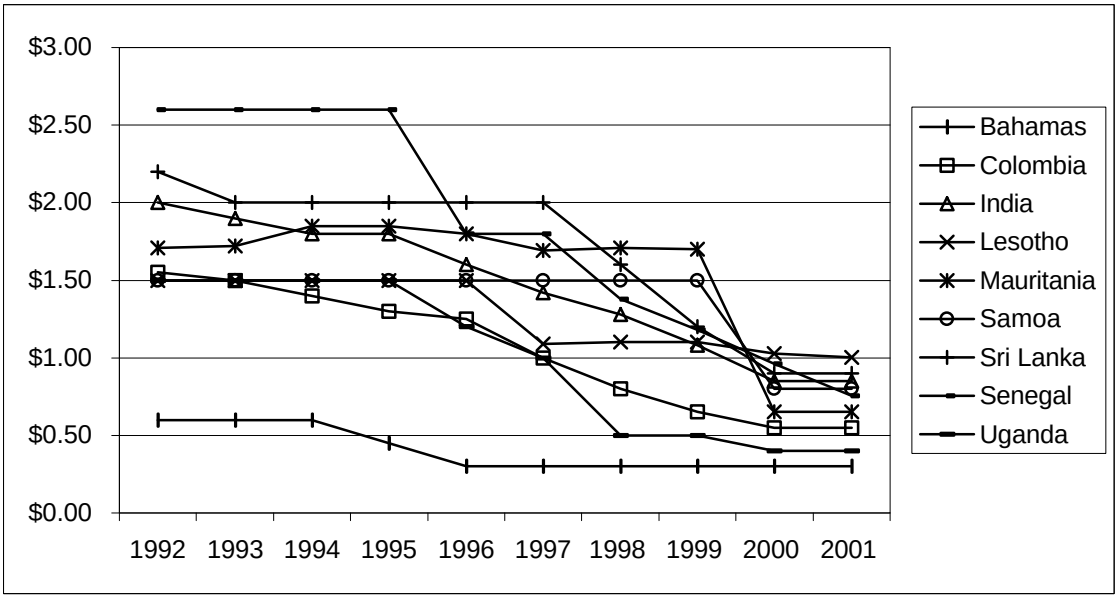


Figure 20 US accounting rates with ITU 1998 case study countries
(source: FCC International Bureau)

[47] See for example *Assessment of the leased line markets in the European Union* by Logica Consulting, at http://europa.eu.int/ISPO/infosoc/telecompolicy/en/llineb08b0.pdf

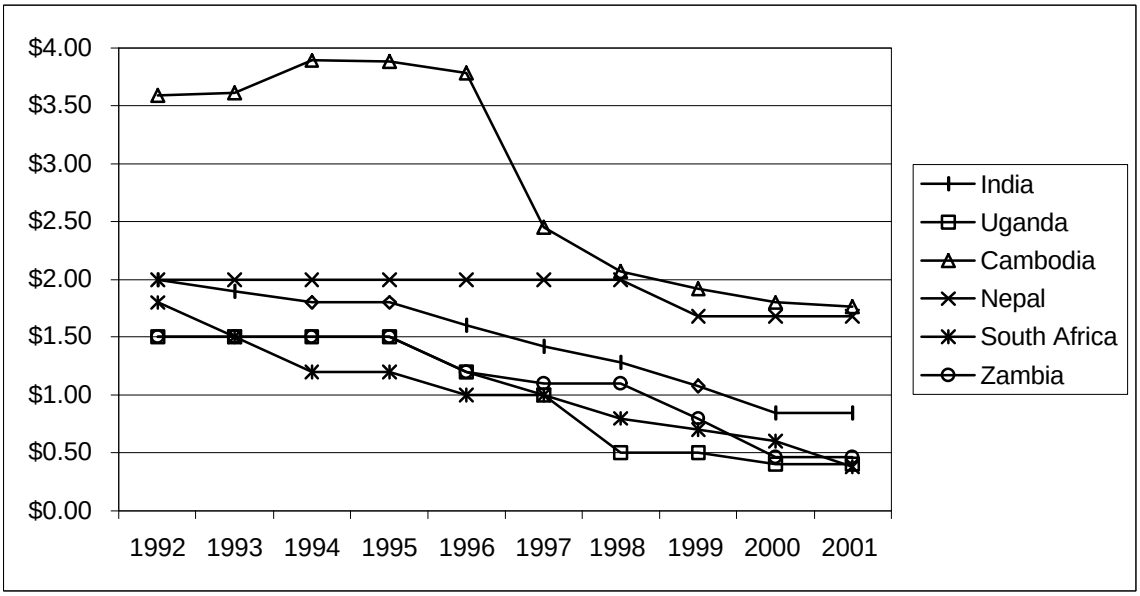


Figure 21 US accounting rates with DFID 2001 case study countries
(source: FCC International Bureau)

The ITU's World Telecommunications Policy Forum in 1998[48] was devoted to the changing international telecommunications environment and its effect on developing countries. Simply stated, the situation was:

- The costs of carrying international telephone calls had decreased dramatically over recent years, because of advances in transmission and switching technology.
- Telephone companies in different countries were still paying each other for terminating international calls using the traditional system of nominally cost-based accounting rates, but these rates were falling much more slowly than the costs they were designed to cover.
- This situation was only sustainable because of the statutory monopolies on international voice still enjoyed by most developing country incumbent telephone companies (though it was becoming very hard to prevent illegal cheap bypass).
- Where traffic streams were in balance between countries, the sums owed in each direction cancelled out, so the discrepancy between accounting rates and cost was not of great importance.

[48] Proceedings and case studies available at http://www.itu.int

- However, countries receiving more international calls than they originated were making large profits on their international call businesses.

- Many developing countries were in the latter position, with some of them relying heavily on their international businesses to keep their companies in profit despite local rentals and call charges which were well below cost.

- The United States was making a net outpayment of around $5bn a year to other countries, most of which the Federal Communications Commission (FCC) regarded as unjustifiable on cost grounds.

The FCC unilaterally declared that international accounting rates should fall over the next few years to much lower ("benchmark") levels. These levels were calculated on the basis of an FCC methodology which itself made large unwarranted assumptions about underlying costs.

The ITU then commissioned a series of case studies of developing countries, with the aim of assessing the true costs and the likely effects on these countries of implementing the US benchmarks. These studies were carried out with the co-operation of the telephone companies in the countries concerned. It was in these companies' interests to publish data which would demonstrate high underlying costs of their international businesses, but none did so.

The consultants however produced cost estimates on a variety of bases, which showed very high profits at then current accounting rates, although not always at the proposed US benchmark rates. The average effective estimated cost per minute was around 35 US cents, the range being 44 to 15 cents per minute. Another indication of costs may be derived from the intra-regional accounting rates recently adopted by the TAS country group (to take effect from 2002). Produced by the countries themselves, these are supposed to be cost-based and are around 55 US cents (representing both ends of the connection, ie a single end cost of 27 cents).

Accounting rates over the last decade between the US and the ITU case study countries are shown in Figure 20. Similar data is shown in Figure 21 for the current set of case study countries. The settlement rate (which is supposed just to cover costs, including a reasonable return on capital employed) is half the accounting rate. We see a common pattern of reductions across all countries, but with some rates remaining very high even now, especially those for Cambodia and Nepal.

The relevance of this situation to the current study is as follows:

It is widely and openly acknowledged that many developing country telcos have made a high proportion of their profits on their international businesses. Box 1 provides an illustrative statement.

In recent years accounting rates (and, to a lesser extent, call prices to customers) have been falling, but in most developing countries they are not yet at levels which eliminate these high profits; nor have the statutory monopolies which sustain the situation yet been dismantled.

It has been a commercial necessity for the telephone companies to keep the price of International Private Leased Circuits (IPLCs) high. Otherwise, they would probably be used to provide competitive international phone service undercutting the incumbent's prices[49], even if that were illegal[50]. Box 1 provides an illustrative statement. Nepal provides a good illustration – the previous trend of growth in international phone calls was curtailed and reversed following NTC's halving of its IPLC prices in 1999 (itself a reaction to the opening of data IPLCs to competition)[51].

Reliable data which demonstrate telephone companies' costs of international facilities are hard to come by – both because of considerations of commercial confidentiality, and because of simple lack of accounting data and appropriate analyses. International private leased circuits use the same underlying facilities as international phone calls and are equally difficult to cost accurately.

In conclusion, it is well-known and widely accepted that many countries (with some developing countries foremost among them) are making high profits on IPLCs. Unfortunately, however, it is not possible to estimate the level of these profits with any degree of accuracy.

[49] For example: assuming a voice compression factor of 4:1 and 8,000 minutes of use per voice channel a month (the assumptions used by the FCC in its benchmarking exercise), a 2Mbps IPLC resold as phonecalls at a competitive price of 23 US cents a minute (the highest of the US benchmarks) would generate a revenue of $221,000 a month.
[50] Various mechanisms are used to provide cheap calls, including callback (which reverses the direction of the call and therefore of charging) and refile (where calls are rerouted via a third country). Reasonably priced IPLCs encourage such activities, which are often illegal.

Mr Sarad B Thapa of NTC, Nepal at the February 2001 APT meeting on Internet charging[52]:

"The price of circuit switched international telephony in developing countries is kept too high to subsidise the local traffic and to generate funds for the expansion of the network".

Extract from report by a delegation from BTTB, Bangladesh, following a study visit to India in January 2001[53]:

"The team asked whether they face any problem with illegal voice call bypassing normal PSTN routes. They replied that there are problems but that [they] are not rampant due to strict measures taken by the authority. Whenever a new IPLC or VSAT is set up the applicant must let the authority know where he wants to set up and exactly what equipment they will connect to. There is a Technical Evaluation Committee (TEC) who evaluates the application, visit the place and assess the requirement. Not only that, the TEC also visits the places regularly (each month) and submits report. If any of customer is seen to have connected any other equipment other than what they have mentioned earlier, the customer's connection are terminated and the equipments are seized. To get rid of the huge revenue loss due to International Call bypassing, this kind of methodology shall have to be taken in our situation also. And strict measures should be taken against the violator."

Box 1 Illustrative statements from incumbent telephone companies

[51] The Internet from the Top of the World: Nepal Case Study, ITU, 2000 (http://www.itu.int/ti/casestudies/nepal/nepal.htm).

[52] http://www.aptsec.org/astap/IP-based_Networks/Documentation/Papers/ASTAP01.EG.NM.AD.07_InternetCharging.doc

[53] http://www.bttb.net/Report_India_Visit.pdf

Attachment 5: Technical aspects

A5.1 International Internet interconnection

The vast complexity of the Internet is hard to visualise, although many varied efforts have been made to this end[54]. To understand the current position of developing countries, the reader is referred to an excellent chart available on-line[55]. This shows the headquarters of Autonomous Systems (ASs)[56] throughout the world as squares, with straight lines indicating connections between them. The world is seen as if from above the North Pole, with continents and major cities labelled at their longitude around the edge. Distance from the centre (where most content is located) corresponds to the "peering outdegree" (a measure of connectedness) of an AS[57].

The deeply coloured (that is, densely interconnected) sector at the bottom of the map, including a large number of squares near the middle, represents North America. The bare sectors on either side show the sparsely populated Atlantic and Pacific Ocean areas, bounded by the more lightly coloured sectors covering Europe on the right and East Asia on the left. Here the AS squares are further from the centre and less numerous. Most striking is the bare area at the top of the map, which corresponds to Western Asia (from the Middle East to Thailand). Its huge population is connected by only a few AS, none of them tightly tied into the world network. The polar projection leaves Africa obscured by Europe, but only one AS is identified as having its headquarters there (Pretoria).

There is a good correlation between peering outdegree and the delay that a user will experience in accessing Internet content. The more ASs that are involved in an Internet connection, the longer it takes for packets to traverse it, and the greater the probability that at least one of the network links will be congested. There is also some correlation, though a less clear one, with the underlying cost of making the connection. A user attached to an outlying AS has to use more links to access given content, and each has a cost. What is more, the additional links are inherently

[54] A valuable collection of these is at http://www.cybergeography.org/atlas/atlas.html

[55] Produced by the Cooperative Association for Internet Data Analysis (CAIDA) of the University of California. May be viewed at http://www.caida.org/analysis/topology/as_core_network/AS_Network.xml (cannot be reproduced adequately in hard copy).

[56] An Autonomous System may broadly be thought of as the network of one Internet Service Provider (ISP) or the networks of a group of ISPs having a common routing policy.

more expensive, because the outer links have lower capacity than the inner ones and hence higher unit costs.

An important limitation to note about the CAIDA chart is that it shows only one square, at the headquarters, for each IBP. In fact all these networks are established at several global nodes, nearly always including a European capital as well as both coasts of North America.

A5.2 Expected technical developments

The most significant relevant technical developments expected over the next few years are continuations of the trends discussed in chapter 2, towards lower **international transmission costs.**

National and local transmission costs should also fall, if less dramatically. The technologies likely to be deployed are:

Optical fibre links. These will increasingly become the norm for transmission within cities, as well as for national and international transmission.

Cable television networks. Unless installed recently with Internet access in mind, these typically require enhancement to make them bidirectional (so that users can both send and receive information); until this is done, the users depend on the telephone network to complete Internet connections.

Satellite links. These can be seen as alternatives to either long-distance optical fibre links or cable television networks. Again bidirectional transmission is more expensive and less widespread than unidirectional transmission; it needs more elaborate user equipment, with higher power consumption. Individual users may use unidirectional satellite transmission in conjunction with another, bidirectional, link for Internet access, because of the delays inherent in satellite transmission (especially for geostationary satellites). An innovative scheme for bringing community radio and Internet to remote areas of Niger using satellite links is worth noting[58].

Terrestrial television networks. These, too, suffer from not offering bidirectional transmission, although the technology is now beginning to permit low-bandwidth return path transmission (that is, from the

[57] Thus LINX, the London Internet Exchange, which is strongly interconnected, appears about a third of the way from the centre along the "3 o'clock" line.
[58] See http://www.isoc.org/oti/articles/0401/gallagher.html

user to the ISP). Where a telephone line is available, it can be used for this purpose.

Digital Subscriber Loop (DSL). DSL can enhance the capacity of an existing local network. However, it requires the network to use high-quality copper wires stretching only a few kilometres from the telephone exchange. In some developing countries, copper cable is prone to theft.

Fixed Wireless Access (FWA). FWA could have particular applications in developing countries where demand is thinly spread and there may be no existing infrastructure. Unfortunately in the USA and Europe FWA is not proving the success that was once projected; it may therefore not achieve the economies of scale needed to fulfil the promise that it could have for the rest of the world. Innovative wireless technologies have however already been devised in Southern Africa for extending rural access to adjacent areas [59].

Initiatives are afoot in different countries to lower the cost of **Internet-capable terminals**. Some of these are based on enhancing the capabilities of televisions and mobile phones, others on cutting unnecessary capabilities out of personal computers, while a few are specific to cheap Internet access. Most are primarily designed to spread Internet access in developed countries, but may still be relevant to the developing world. Chinese activities are likely to be especially worth watching.

The Internet Engineering Task Force (IETF) has many active working groups. Typically these do not address the concerns of developing countries directly. Among the areas of activity which may nonetheless be relevant are:

Multicast. This lets a single source distribute content simultaneously to multiple receivers. Obvious applications include information dissemination, hazard control, and distance education. Work is being done to make multicast suitable for use where more than one service provider is needed to complete the communication chain.

Robust Header Compression. Even in IPv4 the packet headers can form a significant overhead, especially for voice applications, where it is up to 50%. Current techniques for compressing the headers are not robust over low-quality narrowband links. Planned improvements are

[59] See Zambian case study, http://www.firstmonday.org/issues/issue5_10/smith/index.html , and http://www.isoc.org/oti/articles/0401/gallagher.html

intended principally for wireless networks, where bandwidth is scarce and packet losses are high, but will be equally applicable to low-quality wireline networks.

Zero Configuration Networking. This should reduce the skill level needed when administering IP networks. Its initial impetus is support for home and transient networks exploiting simple Internet appliances; uses in developing countries might include telecentre management and hazard monitoring.

All these activities represent moves towards lowering costs, by amounts which cannot be quantified, but which taken together should be useful. However there is one major area of development which will inevitably raise costs: the transition to the next generation Internet protocol. We discuss below how this transition needs to be carefully managed.

A5.3 The move to IPv6

The current version of the Internet Protocol, IPv4 (version 4), has 32-bit addresses; this is, in principle, enough for 4.2 billion addresses, but early allocations of large blocks of IPv4 addresses have lowered the efficiency with which these 4.2 billion can be used[60]. The 'next generation' protocol, IPv6 (version 6), which has existed technically for several years, has 128-bit addresses, in principle enough for 340 billion billion billion billion addresses. The address supply provided by IPv4 is plainly inadequate for the long term, but it is very uncertain how fast the world as a whole will move towards IPv6, or how fast IPv4 addresses will run out[61].

It is significant that the Universal Mobile Telecoms System (UMTS) industry is actively working for a move to IPv6. If successful, UMTS will need many addresses. It is a new service, potentially supported on new network infrastructures. Japan is also proving a leader in IPv6 takeup, closely followed by Korea, Taiwan and others in that region. However, the Internet community as a whole is proving reluctant to migrate to IPv6, in the belief that doing so will be complex and expensive. Many issues remain to be resolved before transition mechanisms become clear. Meanwhile, various expedients have been adopted to manage Internet expansion within the IPv4 address space[62]. In parallel, IPv4 is being enhanced in other respects to match other improved capabilities of IPv6.

[60] For comparison, the UK telephone numbering scheme has a theoretical capacity of 10 billion telephone numbers.
[61] See for example http://www.ripe.net/ripe/meetings/archive/ripe-38/presentations/RIPE_Jan_01_%20IPv4_Address_Exhaust_draftB/sld001.html
[62] The expedients include Classless Inter-Domain Routing (CIDR) and Network Address Translation (NAT).

Early adopters of IPv6 will face additional cost in interfacing with IPv4 (where by far most content is), in finding software that uses IPv6 without reducing performance, and in obtaining bandwidth to carry the larger headers[63]. In any case, the two versions will co-exist and interwork indefinitely. We therefore suggest that:

> ISPs in developing countries should time their transition to IPv6 with care. Those with really big requirements for address space and low needs for external access are more likely to be early adopters.
>
> Participation in relevant regional industry bodies should be particularly fruitful for Asia-Pacific countries, for both keeping in touch with and influencing developments.

Governments of rich countries should support efforts to help ensure conservation and fair management of remaining v4 address space, with particular concern for sensible allocations to countries so far having very little space. Some sparsely-used early allocations have been returned for reallocation, and it may be possible to achieve more in this area. To find exactly what steps should be taken would need further study.

[63] The overhead due to the header depends on the type of packet, but can be as high as 300% for compressed voice carried over IPv6, compared with 200% for compressed voice carried over IPv4.