UNCTAD/SDTE/ECB/2005/1

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT
Geneva

INFORMATION ECONOMY REPORT 2005

CHAPTER 2

UNITED NATIONS
New York and Geneva, 2005

Chapter 2

INTERNATIONAL INTERNET BACKBONE CONNECTIVITY: ISSUES FOR DEVELOPING COUNTRIES

A. Introduction

Are Internet users in developing countries subsidizing users in the industrialized world? If so, is this the result of unfair, anti-competitive practices? Could this be making Internet access less affordable for developing countries than it needs to be? Is there any practical way to redress such a situation? These are some of the questions that arise from the criticisms being made of current arrangements for the access of developing countries to the services of major international Internet backbone providers.

When international telecommunications were largely a matter of interconnection of national telephony networks, developing countries were net recipients of financial flows as a result of the operation of the mechanisms that historically have regulated international telephony in the framework of the ITU (the so-called accounting rate system). The evolution of telecommunications technology, and profound changes in the organization of the global telecommunications industry, put these mechanisms under severe pressure as more and more traffic flows outside the accounting rate system (using the Internet) or is re-routed to take advantage of lower-cost routes that are not necessarily the most direct ones.

The largely unregulated Internet international connectivity arrangements in place between global Internet backbone providers and lower-tier developing country providers represent a radical departure from the traditional telecom model in which the general principle applied to international interconnection was that the operators shared the costs of calls terminated in each other's networks. In the case of Internet backbone connectivity, the arrangements between the concerned parties can theoretically take different forms, which will be described later in this chapter, but in practice the most frequent case is the one in which the operator in the developing country pays the full cost of the connection between its network and that of the backbone service provider, regardless of the fact that the connection is actually used to carry traffic in both directions.

Criticism of these arrangements has been heard in a number of international forums, most recently in the context of the World Summit on the Information Society, or during the cycle of regional conferences on ICT, competitiveness and development organized by UNCTAD in 2002–2003.[1] Critics among developing countries' Governments and civil society entities have argued that the resulting payments may be draining scarce resources away from developing countries, raising costs to local Internet users and hindering the emergence of information societies in the developing world. Critics consider them to be inequitable and to result sometimes from anti-competitive practices. Some claim that the arrangements amount to a reverse subsidy that is being paid by developing country Internet service providers (ISPs) to international backbone service providers and to their customers in developed countries, who benefit from cost-free access to the networks of developing countries.[2]

While a return to traditional, regulated compensation mechanisms is not generally considered to be a viable option, there are doubts about the possibility of a laissez-faire attitude resulting in a satisfactory solution to the perceived inequities of the system. Because of the impact that international backbone connectivity costs are claimed to have on overall Internet connectivity costs in some developing countries, and hence on the access of their population to the Internet, the question of the need for alternative arrangements has featured among those proposed for inclusion in the global Internet governance agenda.

The purpose of this chapter is to look into the effects of the arrangements under which ISPs in developing countries have access to the Internet backbone, including the effects of conditions that are determined at the domestic level, with the focus on their consequences for the affordability of Internet access for businesses and households, and to explore the options that are available to counter any negative effects that may be identified. In order to do so, the chapter will first briefly describe the economic foundations of the various modes of operation of the market for Internet backbone interconnection, and the aspects in respect of which they may be different from traditional telecommunications markets. This will be followed by an account of recent developments in the global markets for bandwidth and interconnection services, with a particular focus on the availability of backbone connectivity in the developing regions of the world, the extent to which connectivity is being provided under competitive conditions, and the way in which this has affected the cost of connecting to the global backbone for lower-tier operators from developing countries. There then follows a presentation of the international debate about the imbalances and inequities that are said to prevail in the international arrangements for Internet traffic exchange between the developed world and developing countries, and possible remedies that could be identified. The chapter ends with the presentation of a number of policy options and proposals that may be envisaged both at the domestic and international levels in order to reduce the costs that the ISPs of developing countries face in accessing international backbone as well as the overall cost of Internet use in those countries.

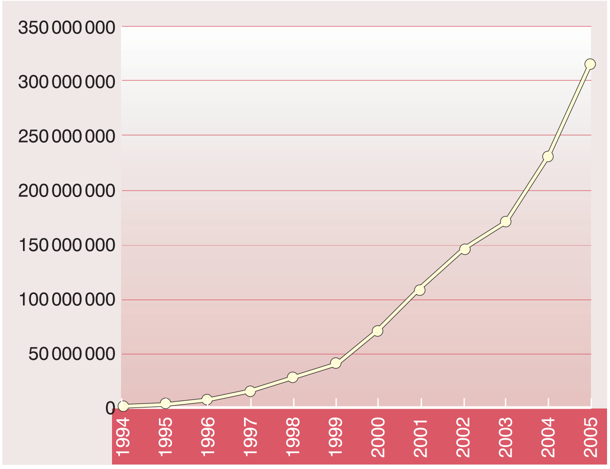
B. Economic aspects of backbone connectivity

1. The Internet backbones

The Internet can be defined, with some simplification, as an open, worldwide network that interconnects computer networks using a number of standardized protocols in order to allow the exchange of data among them. There are fundamental differences between the Internet and older global telecommunications networks, some of which are more than a hundred years old; such differences play an important role in making the conditions of competition in Internet services significantly different from those in telephony. The first one relates to the different functions that protocols and infrastructure perform in the Internet and in telephony networks. While the Internet protocols are what constitute the essence of the Internet and have enabled its emergence and explosive growth (see chart 2.1, which shows how the number of Internet hosts grew from slightly over 4.8 million to more than 317.million in the last decade),[3] the hardware of the Internet, the physical networks of cables and the computers they interconnect, are not conceptually different from those that existed prior to the emergence of the Internet.

Chart 2.1

Number of hosts advertised in the DNS



Source: Internet Systems Consortium (2005).

The second differentiating factor to keep in mind when comparing the Internet with older telecommunications networks is the fact that in the Internet the intelligence lies at the periphery of the network and the core is relatively dumb – and thus subject to a trend of commoditization and declining prices – whereas in telephony networks the opposite is true.

Several explanations have been proposed for the fact that structural differences between telephony and the Internet can translate into differences in the financial arrangements of interconnection (see box 2.1). These explanations refer to aspects such as the following: the different role that networks play in the determination of the service provided – in telephony the network determines the services provided, while in the Internet these are determined by the end systems and remain transparent to the network; the different transactional units (“call minutes” and “data packets”) that are not comparable because the requirements they impose on the network are rather different; the different network reliability requirements; and the fact that while network paths in transmissions are not necessarily symmetrical in the Internet, they must be so in telephony.[4]

In order to connect to the Internet any computer must be part of a network. In the most basic example, a private user connecting from home or a small busi-

Box 2.1

A comparison between settlement mechanisms in telephony and Internet services

Traditional telephony networks are based on the switched-circuit model. In this model a single channel (circuit) connects the two ends of the communication and is reserved for the transmission of the message for the whole duration of the transmission. No other traffic can use that particular circuit while the communication takes place and the message is exchanged intact over the dedicated circuit. This contrasts with the packet-switched approach used by the Internet, in which the information to be communicated is broken up into smaller "packets" that may travel to their destination using different routes over the most efficient circuits available at any point during the transmission.

Historically, the framework for the relations between telephone operators of different countries √ which typically were State-owned monopolies √ was based on agreed accounting rates to be charged for carrying one minute of international voice traffic from the originating network to the destination network. In theory, accounting rates were fixed at levels that covered the total cost of carrying the voice traffic from one end of the call to the other. Operators shared the costs by paying each other a share of the accounting rate (normally 50 per cent) for the termination of the call on the other operator's network. At the end of the agreed period the operators settled their accounts and the operator with a net inflow of traffic received an amount equal to the agreed accounting share multiplied by the net incoming minutes of traffic.[1] Because of traffic patterns, in the case of links between developed and developing countries the receiving operator normally tended to be the one from the developing country. In 1998, the ITU agreed on three new procedures for remunerating the party that terminates international traffic. These were "termination charge procedure" √ the operator that terminates a call can make a single charge for this, under agreed conditions; the "settlement rate procedure" √ using negotiated cost-oriented and asymmetrical settlement rates; and the "commercial arrangement", which in countries that have liberalized telephony services allows operators to agree bilaterally on the remuneration regime that is best suited to their requirements.

The logic that underpins the settlement system outlined above is not as different from the one operating in the compensation systems in place for Internet interconnection as it is often said to be. In general, both respond to the volume of traffic that one network passes on to another, although in the case of telephony traffic volume is measured in minutes and in the case of the Internet the unit of measure is megabytes of data. In both cases, if traffic flows more or less equally in both directions, the net financial exchange tends to be zero, either by virtue of peering agreements or through net payments made.

The divergences between the two systems appear in the treatment of the relationship between two dissimilar networks or in the case that traffic flows are asymmetrical. In this case, in the telephony system, financial flows follow the same direction as the net traffic flows: the network originating most of the calls pays a fee to the network that terminates the calls. In the case of the Internet, the net flow of payments tends to go in the opposite direction to the net traffic flow. Smaller ISPs with less traffic pay larger ISPs with more traffic (customers) for the right to send their traffic through the larger network (transit). As a result, while traditionally the international telephony regime has resulted in financial flows going from developed countries to less developed ones, (in large part because developed countries make more calls to poorer ones than viceversa), in the case of the Internet, the financial flow is reversed: ISPs from developing countries tend to make net financial payments to NSPs, which are generally headquartered in developed countries.

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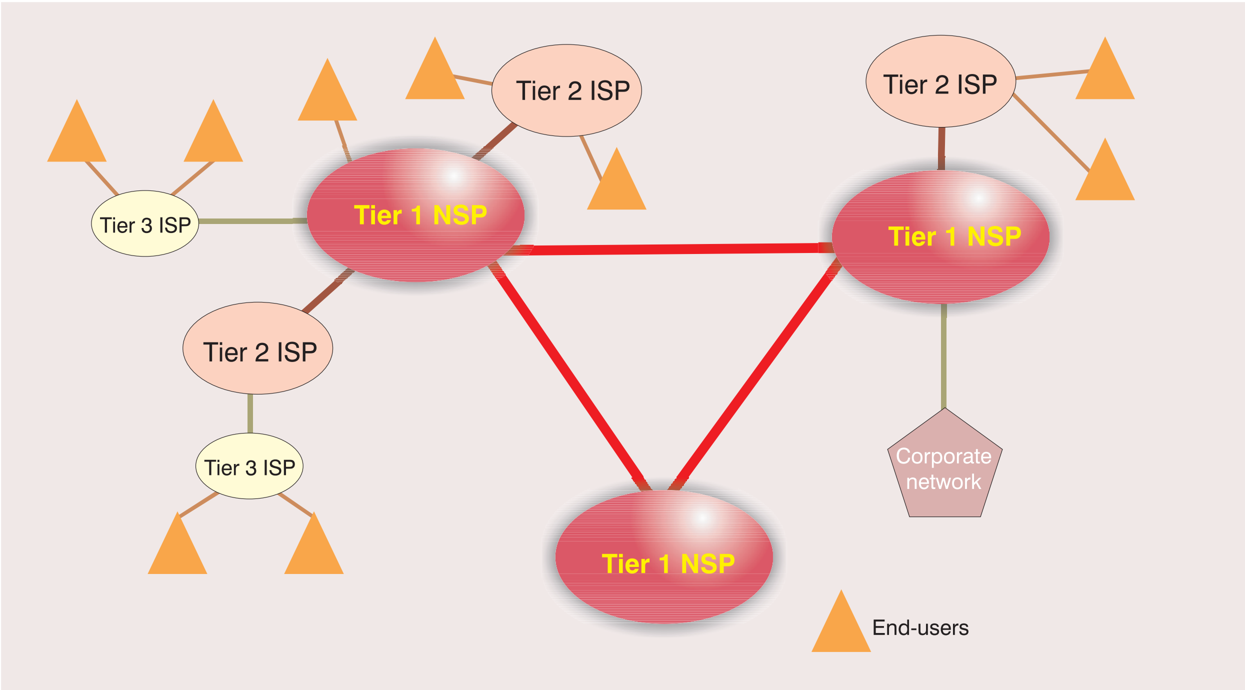
[1] See a description of the accounting rate system at ww.itu.int/osg/spu/intset/whatare/howwork.html.

ness must use a modem and a telephone line to dial up to an ISP, which can be either a commercial operator or a government, research or educational institution. The user may also connect to the ISP using any of a variety of broadband technologies (DSL, cable, wireless) that are increasingly being adopted in most developed and some developing countries, as indicated by the data provided in chapter 1 of this Report. In any case, regardless of the technology used for the connection, the previously isolated domestic computer becomes, for the duration of the connection, part of the ISP's network. Many business users access the Internet from the local area networks of their enterprises, but in most cases they will still need to connect to the Internet through an ISP. If the ISP itself is not a large operator, it may aggregate traffic from its customers and buy direct Internet access to a larger ISP, often a telecommunications operator. In either case, routers and switches owned by the ISP will direct the data packets (the traffic) it receives from its customers to a local Point of Presence (PoP).[5] Through these PoPs, traffic is passed on to high-speed hubs, which are in turn connected to other hubs at considerable distances using high-speed circuits that are generally owned by major telecommunications operators.[6] These hubs and the long-haul, high-speed circuits that connect them constitute an "Internet backbone network". Internet backbone networks connect to each other into the global Internet.

Thus, a hierarchy of tiered networks emerges: tier 1 consists of very large network service providers

Chart 2.2
Three tiers of network/Internet service providers



(NSPs) that own their own fibre optic or satellite links across nations and around the world, for example those of companies such as AT&T, Cable & Wireless and BT. Many operate also as ISPs, selling services to final users; others focus exclusively on the wholesale market, selling bandwidth to tier 2 and tier 3 providers. Tier 1 providers can also be defined as ISPs that have access to the global Internet routing table but do not purchase transit from anyone.[7] Tier 2 ISPs buy capacity from tier 1 providers for resale. They have networks with a more limited geographical coverage (there are some 100 in the United States, for example) and they have to rely on tier 1 NSPs to carry their traffic outside their region. However, they own their own PoPs and backbone nodes. The customers of tier 2 ISPs tend to be final users (businesses and households), but also include tier 3 operators. Tier 3 consists of the small ISPs, providing services exclusively to end users and usually active within a small geographical area. They must connect to either tier 2 or tier 1 providers in order to access the Internet through the latter's backbones; they may also have to lease their PoP facilities. Chart 2.2 provides a graphic representation of this model.

During the earliest phases of the development of the Internet there was a single Internet backbone network, the ARPANET (Advanced Research Projects Agency Network of the Department of Defense of the United States), which originally (1969) consisted of four nodes, all located in the continental territory of the United States. In 1989 the NSFNet (National Science Foundation Network) backbone was established and ARPANET ceased to operate. By mid-1995, as the Internet began its phase of explosive growth and globalization, a new architecture replaced the NSFNet and commercial networks, interconnected at network access points (NAPs) and later at Internet exchange points (IXPs), emerged as the providers of backbone services for the global Internet.[8] To a large extent, the fast rate of growth of the Internet was made possible by the inherent characteristics of the Transmission Control Protocol/Internet Protocol (TCP/IP) as a public domain standard: its cross-compatibility and the protection against obsolescence that openness provides. This facilitated investment in Internet technologies and the growth of the network. The public domain nature of TCP/IP, as will be explained later, also constitutes an important consideration in securing lower barriers of access in Internet interconnection services as opposed to other telecommunications technologies.

The meaning of the term "Internet backbone" has changed significantly since the time when ARPANET and NSFNet were created. These networks were true

Table 2.1

Largest NSPs by number of autonomous Systems Connections (2004 and 2000)

Provider	Rank 2004	Number of autonomous systems connections 2004	Rank 2000	Number of AS connections 2000	% change in AS connections
MCI	1	3 034	1	2 242	35
AT&T	2	1 966	4	695	183
Sprint	3	1 842	3	1 036	78
Level 3	4	1 167	5	658	77
Qwest	35	1 074	6	418	157
Intermap	6	668	11	211	217
Savvis	7	664	12	210	216
NTT	8	636	8	379	68
Global Crossing	9	616	10	217	184
AboveNet	10	590	13	207	185

Source: Analysys Consulting Limited (2005), quoting Telegeography Research Global Internet Geography 2004.

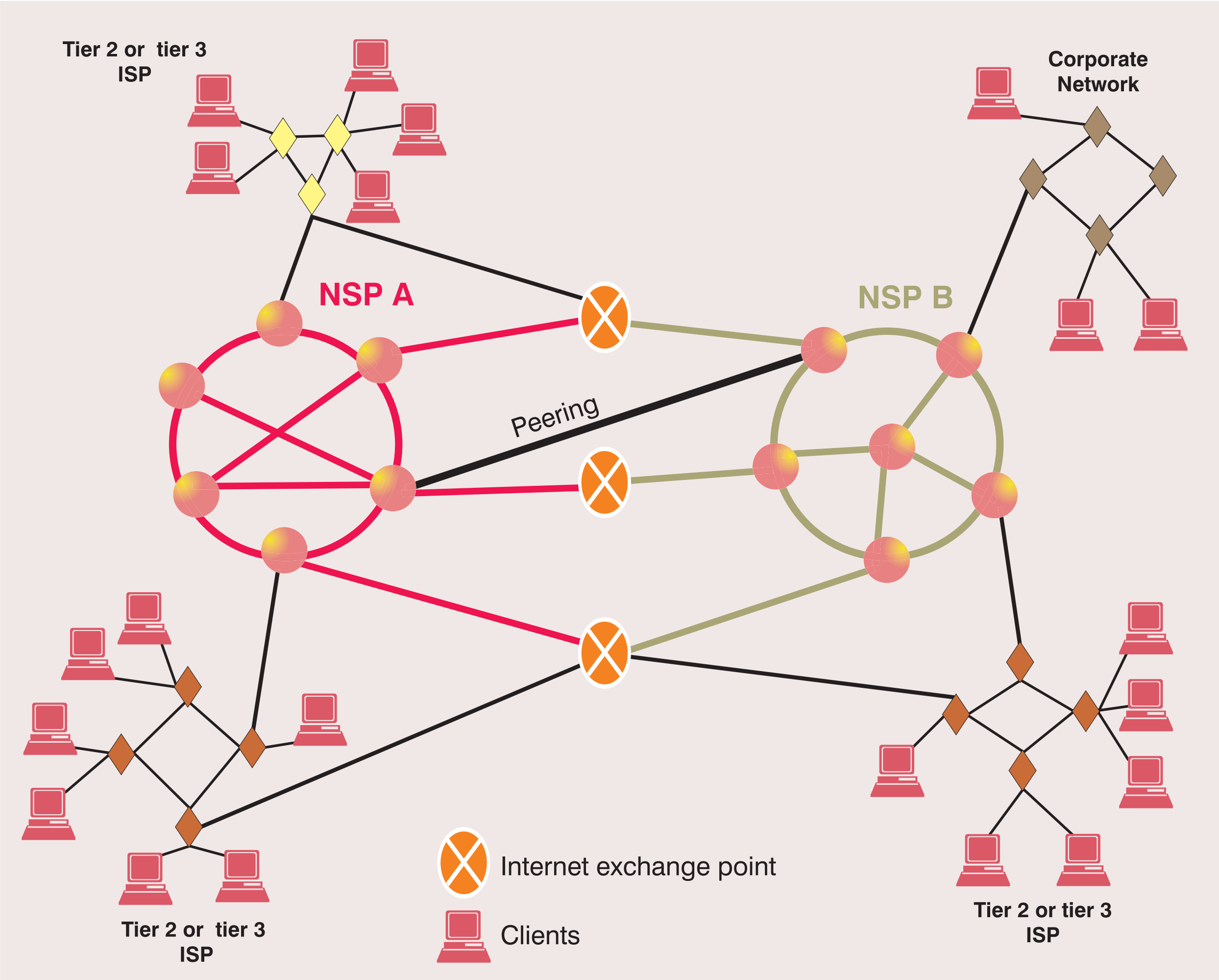
backbone networks in the sense that they connected all the elements of the Internet as it existed then. Today the term "Internet backbone" has taken a different meaning and is generally used to designate, in a rather general way, the core physical infrastructure that carries IP traffic. In this regard, it is important to stress that the Border Gateway Protocol (BGP), a major Internet protocol that is used for routing traffic, ensures that the Internet operates without the need for any single "central" network. Over 300 operators provided commercial backbone services as of the end of 2004 and the broader network services industry sales are estimated at about $1.3 trillion worldwide.[9, 10] The failure, or even the disappearance of any of these backbone networks, would therefore have no significant impact on the overall functioning of the global Internet. Of course, backbone networks offer a widely varying level of capacity and geographical coverage, and consequently their market shares vary considerably, with a process of consolidation taking place in the industry among operators of all three tiers. Of the 300 backbone networks mentioned before, the top 50 carry nearly 95 per cent of all IP traffic, and only five of them can be considered to have a truly global presence.[11, 12] AT&T Corp. (currently in the process of a merger with SBC Communications Inc.), MCI Inc. (which has a merger agreement with Verizon Communications Inc.) and Sprint Corp. (which announced a merger agreement with Nextel Communications Inc. in December 2004) own the three most-connected backbone networks (based on autonomous system connectivity).[13, 14] Table 2.1 lists the largest NSPs ranked by number of connected autonomous systems in 2004 and 2000.

The predominance of operators headquartered in the United States (all of them except NTT) is clear, in spite of the growing decentralization of the Internet. Another notable feature of the ranking is its stability between 2000 and 2004. Only three providers that were among the top ten in 2000 do not show up in the 2004 ranking. Of the top ten in 2004 only half are traditional telecommunications operators. Finally, the top five providers have significantly more connections than the others, but their growth is slower. This could indicate that as smaller ISPs increasingly establish peering interconnections among themselves, their need to obtain transit from major backbone providers decreases.

Chart 2.3 shows how different backbones interconnect at IXPs.

For ISPs to be able to provide their end users with the service they demand – the possibility of sending traffic to and receiving traffic from, any other computer connected to the Internet – they need to ensure that they can exchange traffic with other ISPs. This exchange happens at so-called peering points. Networks can interconnect in several ways: (a) through private bilateral interconnection; (b) through a public NAP or IXP; or (c) peering in a customer–provider relationship. In any event, peering will require three elements: the facility where the physical connection

Chart 2.3
Three tiers of network/Internet service providers



between the networks takes place, the technical linkage between the networks to allow for the routing of traffic and the contractual (commercial or otherwise) arrangements that regulate how traffic is going to be exchanged among the networks.

Tier 1 providers tend to peer among themselves without charging each other (on the basis that traffic flows roughly equally from and into each network), in "bill and keep" agreements. Since these providers tend to charge for peering with smaller ISPs, the latter tend to converge into IXPs, which allow them to exchange traffic in a more balanced way. An IXP is a facility that several ISPs can jointly own and run in order to exchange traffic between their networks using peering agreements and thus reduce their dependence on higher-tier providers. IXPs also improve quality of service, notably through significant reductions in network latency.[16] As for the customer–provider relationship, which is more prevalent in the lower tiers, it cannot be considered a proper peering relationship (participants are not equals), as the customer is paying for his traffic to transit through his upstream ISP.

Interconnection at IXPs is governed by bilateral agreements between the parties involved. The negotiation of such agreements is sometimes facilitated by the publishing of a set of rules and standards adopted by the IXP itself[17]. In other cases the IXP does not impose any conditions or norms on the contracts made by third-party networks using it. As mentioned above, some contracts do not require financial payments between the networks exchanging traffic; in this case, the payment takes place in kind (by mutually accepting traffic from the other network), and this is what some consider to be "true peering".[18] Other arrangements require financial payments in exchange for connectivity, a mode of relationship between networks called "transit".

The choice between peering and transit as an interconnection modality is a commercial one.[19] Peering will be chosen if both participating networks expect to see their cost equally affected as a result of the traffic flowing between them. The determining factor in the decision to peer or to transit is the impact on cost, and not the relative size or traffic volumes of each of the participating networks. Two networks very dissimilar in terms of size may generate symmetrical traffic flows provided that their respective customers (ISPs or end customers) are similar.[20] However, similarity between the networks is not sufficient to ensure that peering will take place. Even if traffic volumes are symmetrical, one network may incur higher costs than the other per unit of traffic carried – mainly for geographical reasons – and may therefore refuse to peer with the lower-cost network. Under these circumstances, whether the exchange of traffic between networks takes place on a barter basis (peering) or a monetary one (transit) does not provide an indication of the intensity or otherwise of competition prevailing among networks, but merely of the similarity or disparity between the cost structures of the various players. It cannot be ruled out therefore that the refusal to enter into peering agreements, rather than being an anti-competitive practice, may represent a legitimate commercial choice in view of the differences between the proposed participants.

Beltrán (2004) includes an interesting study of the forces at play in the case of the interconnection agreements in IXPs in several Latin American countries. The author finds that in that region interconnection at IXPs takes place almost exclusively on a peering base, even though participating ISPs can be rather dissimilar by any conventional measure, which would be contrary to the literature, which generally considers these to be the requirements for peering.[21] Although these peering agreements between large and small ISPs tend to be limited to the exchange of national traffic and do not necessarily include international traffic, the study finds that such arrangements may render the IXPs unstable.

Another important factor in the peering versus transit decision-making process is the history of the relationship between the networks. Norton (2002) examines the experience of a large number of ISPs and concludes that even in circumstances that, according to the consensus of the literature, should not lead to a peering agreement, this has been possible. He distinguishes 19 "honest" and "less honest or not honest at all" tactics that ISPs can adopt and observes that peering decisions are heavily influenced by an ISP's record of peering/transit decisions: it is nearly impossible to transform a transit relationship into a peering one.

3. Competition

Because of the technological environment in which backbone providers operate, low barriers to access and cheap expansion of supply capacity can be safely assumed.[22] Customers of NSPs rarely have to settle for exclusive or long-term deals. When ISPs buy the amounts of bandwidth that they need in order to connect to the global Internet (through transit agreements as described above), available information about the prices for ranges of bandwidth capacity points to a healthy level of competition among NSPs.[23] For example, Economides (2004b) includes a comparison of the prices charged by AT&T and UUNET for various bandwidth capacities in early 1999, showing them to be identical for all of them except in the range of burstable 21.01-45 Mbps, where the difference was less than 1 per cent. When bandwidth demand fell behind the expectations generated during the years of the Internet boom and the concurrent growth in bandwidth available from backbone providers, prices started on a downward spiral. Another indication can be seen in Giovannetti et al. (2004). They looked at the prices posted by six major transit providers between July 2003 and July 2004 in the London-based X-Band online bandwidth market,[24] and found that both the highest and the lowest prices had fallen by about a third, that prices had consistently declined during the observation period and that all providers follow the general trend and respond to price falls. They conclude that the scenario corresponds to that of a competitive market.

In developed markets lock-in effects are rare and ISPs can change providers in response to price stimuli without having to bear significant switching costs. The situation is less clear in the case of developing countries, and the theoretical possibility of market failure exists, particularly in the case of regions with very limited physical availability of alternative backbones, such as some landlocked countries in Africa and Asia, or some small island developing States. However, the existence of significant spare capacity and the emergence of virtual NSPs should facilitate an improvement in the variety of connectivity options available to ISPs in those regions.[25] As mentioned before, it is common for ISPs to have agreements with more than one backbone provider, and multihoming allows them the possibility of controlling how their traffic is routed.[26] As in the case of other ICT goods, the price of the routers needed for ISP multihoming has declined significantly over recent years. As a consequence, ISPs increasingly have the possibility of changing the capacity with which they access the Internet by transiting through a given backbone provider, for example in response to changes in prices.[27] This of course limits the capacity of backbone providers to raise their prices. Similarly, the customers of ISPs have the possibility to use "customer multihoming", with similar effects on their capacity to react to price increases by ISPs. Caching, mirroring and intelligent content distribution help reduce demand for backbone carriage for a given amount of content flows.[28]

An interesting question is the extent to which the network externalities of the Internet could facilitate the emergence of a backbone provider that enjoyed monopolistic power. However, considering the conditions that should be met for a provider to be able to exploit network externalities as a way to gain monopolistic power, this appears to be an unlikely occurrence. Those conditions are the following:

- The operator should be able to have exclusive control over the protocols and standards used in the network.
- Its customers should have no incentive to reach the customers and services of more than one network provider.
- Customers should face a high cost if they wished to switch to another network.[29]

The Internet, of course, provides an excellent example of network externalities, since with any new Internet user or computer node connected to the network, or any new network that gets connected, the value of an Internet connection increases for every other user and network connected: there are more websites to visit, more people with whom e-mail can be exchanged, more e-commerce opportunities, and so forth. However, the magnitude of this effect is the subject of some debate. While many assume that Metcalfe's law, which states that the value of a communications network is proportional to the square of the size of the network, applies to the Internet, others argue that this is an overestimation and that the value of a communications network of n members grows like $n \log (n)$.[30] In this case, network effects are not as strong as Metcalfe's law implies. In a network in which Metcalfe's law holds, the value of interconnection is the same for both interconnecting networks, regardless of their relative size. In a network in which the value for participants grows as $n \log (n)$ the smaller network would gain significantly more from interconnection than the larger one. Therefore, there would be a justification for the larger network to demand payment for interconnection, and a refusal to peer would not necessarily represent anti-competitive behaviour.

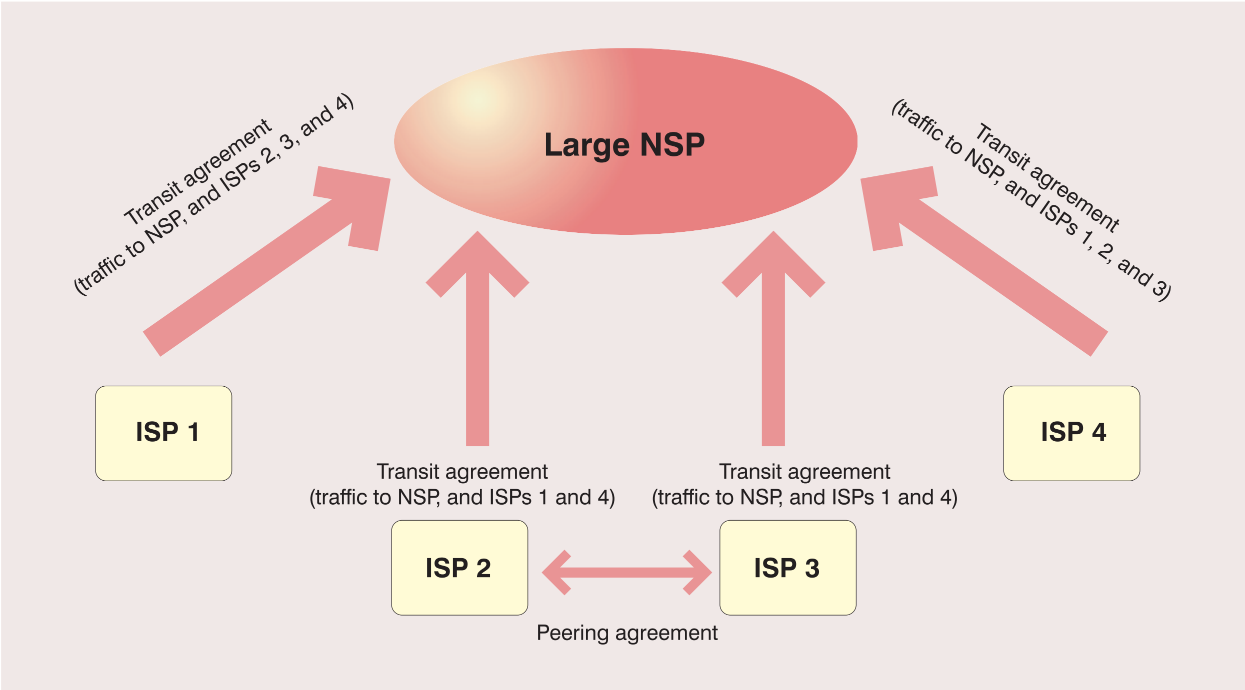
Technological reasons also support the consideration that the conditions prevailing in the market for backbone connectivity are different from the ones in which network externalities could support the development of monopolies. The Internet is based on the use of open, public standards, and the mechanisms through which these standards and protocols are defined and extended make it highly unlikely that proprietary standards would be imposed in the future by any operator.[31]

Another point of view to consider is the behaviour of Internet users. Given the nature of the content available on the Internet, users require universal connectivity: they do not know in advance the location of specific information or service that may interest them. And conversely, users cannot calculate the cost of the loss of opportunities that they would suffer if customers of other backbone providers were unable to access them. Thus, a backbone provider that refuses to provide universal connectivity would be unlikely to succeed. The fact that, in developed markets at least, no backbone operator has exclusive coverage of any extended region and that most ISPs can connect to more than one backbone without major switching costs further adds to the difficulties of the would-be monopolist backbone provider. The influence of users' behaviour can be felt in another way: as the Internet becomes culturally and linguistically more diverse, content and the traffic it generates become less concentrated, thus eroding the market power of established operators.

A large backbone provider could, however, attempt to impose its power on the markets in ways that would be detrimental to its customers. It could, for example, increase the prices of its services, replacing peering with transit agreements at high prices; it could practise price discrimination, charging some networks

Chart 2.4a

Traffic flows before NSP increase prices



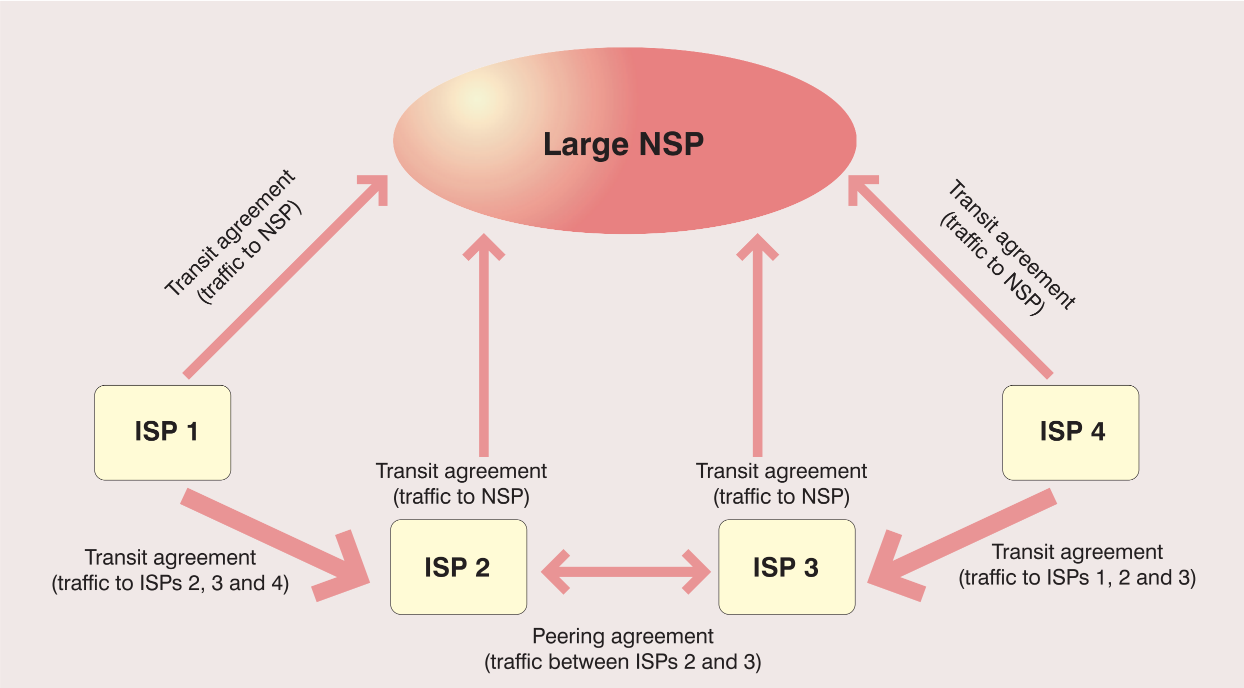
Source: Economides (2004b).

more than others for the same services; or it could deliberately provide interconnection services of lower quality to rival networks in order to divert traffic towards its own network. It would, however, face considerable difficulties in achieving its objectives.

Let us consider the price rise first. The first effect of an increase in price would be to create profit opportunities for its rivals (to which at least some of its customers would switch) and provide an incentive for new operators to enter the market. As explained before, in developed markets it is very common for ISPs to be connected to several backbone providers; ISPs that use multihoming can easily reduce the amount of bandwidth they buy from a given backbone provider. A large backbone provider that attempts to impose increases in transport costs will see other providers and ISPs divert traffic from its network and reroute it using more of the others' capacity.[32] Only traffic destined for ISPs with exclusive connection to the large backbone provider would not be bypassing its network. Chart 2.4, taken from Economides (2004b), shows the situation before and after a price increase in the case of four ISPs that purchase transit from a large provider, two of which peer with each other and buy transit for their traffic to the large provider and the other small ISPs, and the remaining two buy transit from the large provider for all their traffic. As a result of the price increase, all of the ISPs will buy from the large provider only bandwidth sufficient to carry traffic with destined for the provider's own network, which would lead to a significant decrease in revenue for it. The beneficiaries would be the ISPs that had a peering agreement and that would have been able to sell capacity to the other ISPs, and whose networks would have grown bigger.

Price discrimination against rival networks would also be unlikely to be undertaken, as rivals are better placed than any other customers to avoid use of the network of the provider that raises prices. Another option available for an operator attempting to displace rivals could be to deliberately degrade the quality of service it makes available to other networks that interconnect with it. However, this strategy would be very counterproductive, as it would harm the perpetrator as much as any victim. A refusal to deal with other networks would also be a self-defeating option, as customers demand connectivity to be as far-reaching as possible – ideally, universal. A refusal to establish interconnection agreements with other networks would therefore amount to a deliberate reduction of the quality of service provided to its own customers, and would benefit those rivals that would receive the traffic originating from the network to which a deal had been refused. Network externalities in all these

Chart 2.4b
Traffic flows after NSP increases prices



Source: Economides (2004b).

cases seem to be working in favour of greater competition.

The reasoning outlined in the preceding paragraphs seems to support the view that effective competition can be expected to be normally present in the market for Internet backbone services. There seem to be few theoretical reasons to expect the emergence of conditions under which a dominant operator could successfully impose its standards and/or refuse to interconnect other networks as an anti-competitive strategy. This should not be understood as implying that in practice backbone operators could or should be left wholly unsupervised, but merely as a suggestion that the fact that a NSP refuses to peer with a lower-tier operator does not by itself constitute evidence of anti-competitive behaviour. As pointed out by Economides (2004a), inequality is natural in the market structure of network industries. And, as noted before, networks of different sizes face different incentives to interconnect: they are much more significant for smaller networks, and a refusal to peer on the part of the larger ones would not necessarily constitute anti-competitive behaviour.[33]

In spite of the above considerations, even if the theoretical conditions for competition are present in the Internet backbone services market, as in any other market the vigilance of regulators is necessary in order to ensure that the larger operators do not undermine the conditions of competition. After all, the larger the network of an Internet backbone provider, the more tempted it may be to try to impose access terms on downstream networks. And as networks gain financial capacity to buy their potential competitors, barriers to entry for newcomers may become higher.

In these circumstances, regulators in both the United States and the European Union have had to intervene in order to prevent possible anti-competitive behaviour on the part of tier 1 backbone providers. For example, the market for local Internet access remains, even in many developed countries, largely in the hands of telecoms incumbents and there is clear justification for regulatory obligations being imposed on them in order to prevent discriminatory practices that may bottleneck certain facilities and functionalities for rent-seeking. This is the approach followed, for example, by the regulatory framework of the European Union adopted in 2002. In the United States, although the general position of successive administrations has been that when no dominant player was present there was no need for government involvement in the operation of the Internet's privately owned global infrastructure, regulators have sometimes shown hesitation about the impact on the Internet of fully unrestricted market forces: for example, in 2000, when the Department of Justice went to court to block the merger of America's two largest Internet backbone providers (WorldCom and Sprint), because a combined company would control 53 per cent of US Internet traffic – five times that of the next largest competitor. The position of the Department of Justice was that the merger might give the resulting company the capacity to restrict competition through rises in costs and deterioration in the quality of service.

Similar considerations would clearly be applicable to the situation of developing countries with regard to the practical implications of the market power of the largest international backbone providers. An important matter of concern to ISPs of developing countries is the practical actions that could be undertaken in order to prevent global backbone providers exercising excessive market power to shift the investment and operation costs of international access onto the smaller network operators. In order to address this question it is first necessary to look briefly at the evolution of the global market for Internet backbone services.

C. The evolution of the global market for Internet backbone services

1. The developed countries

The analysis in the previous section is based on the experience of the United States, where the first commercial backbone providers started to operate in the early 1990s, and is now applicable in large part to the situation in the rest of the developed world. As the Internet expanded into other regions of the world somewhat later than in the United States – mostly in the second half of the 1990s – ISPs outside that country needed to get connected to North American backbone networks. At that time, in most countries the infrastructure required for that purpose was still owned by monopolies or by the former monopoly, as the liberalization of telecommunications services was relatively recent (or in some cases had not even been completed). ISPs had to use leased lines to get connected to NAPs (originally) or IXPs (later) in the United States. The reason for them to do this was not only that the United States was where the initial backbones and a very large part of the Internet content were located, but also the fact that because more advanced liberalization in that market had brought down the prices of international circuits originating in the United States, a link there provided the most economical way to exchange traffic at the global level. Foreign ISPs could minimize the cost of exchanging traffic by doing so in the United States.

It soon became clear, however, that the situation that was developing was far from optimal from the networking point of view: traffic between neighbouring countries in Europe or Asia was using transcontinental lines to the United States. ISPs thus became interested in setting up national and regional IXPs so that non-US traffic did not have to be carried over United States backbones. Another reason for this interest was the commercial requirement of improving the quality of service provided to end-users, for example reduced latency. As liberalization advanced in most developed countries, the cost of the domestic and regional links to the non-US IXPs fell considerably.

An important force for change was the move by traditional telecommunications operators, the former monopolies, into the Internet services arena in the second half of the 1990s. The infrastructure with which they provided these services, however, had been built under the rules of the circuit-switched model, which meant that they only owned the capacity they needed up to a theoretical mid-way point. In order to serve their customers, most telecommunication operators had to turn to providers with backbones in the United States. This entailed a shift of financial flows between telecommunications operators in favour of those based in the United States, which were already advanced in the building of privately owned, commercially operated international infrastructure. While the incumbent operators – monopolies or former monopolies – still had to buy foreign half-circuits, backbone providers in the United States were already able to carry traffic end to end on their networks.[34]

Since the policy environment in most developed countries was particularly favourable to liberalization, deregulation and privatization of telecommunications services, operators were unable to obtain from their Governments the traditional remedies they would have sought for this kind of imbalance in the relationship with operators from the United States, namely government intervention to regulate prices, and were forced to develop commercial solutions. Regulatory developments on both sides of the Atlantic facilitated the process. In the United States, the 1996 Telecommunication Act encouraged new participants to enter all market segments. European markets were also mostly open for the provision of end-to-end facilities as liberalization moved forward.

Backbone capacity in the United States and international routes linking that country to the rest of the world expanded at a phenomenal rate, giving operators from outside the United States increased options in their commercial dealings with United States backbone providers. In the process prices fell, buyers were able to negotiate better deals and, in spite of some complaints by foreign operators, the backbone market was considered to have moved in the direction of increased competitiveness.[35] Foreign operators were also able to add their own backbone networks through the United States (Cable and Wireless, Telia, France Telecom, NTT, Telecom Italia, Telefonica, among others), which gave them the ability to carry traffic end to end. Indeed, studies seem to indicate that the United States is the most competitive backbone market in the OECD.[36]

The larger operators have in front of them a rather long menu when deciding the kind of relationship they wish to establish with other networks. They can establish partnership agreements with operators that complement their geographical coverage, they can buy spare capacity or dark fibre from other operators, they can swap capacity, or they can simply buy up a company. In line with the description in section B above they can also agree to peer so that they exchange traffic without monetary payments, or conclude transit agreements for all or part of their traffic, with either one or several backbone providers. For most of the large operators from outside the United States, the deployment or acquisition of their United States backbones is part of a worldwide strategy that involves the presence of their own backbones in other regions outside their home country – and sometimes even their own region. This trend, of course, has been reciprocated by United States-based carriers that have also built their end-to-end networks in other parts of the world, particularly in Europe and Asia.

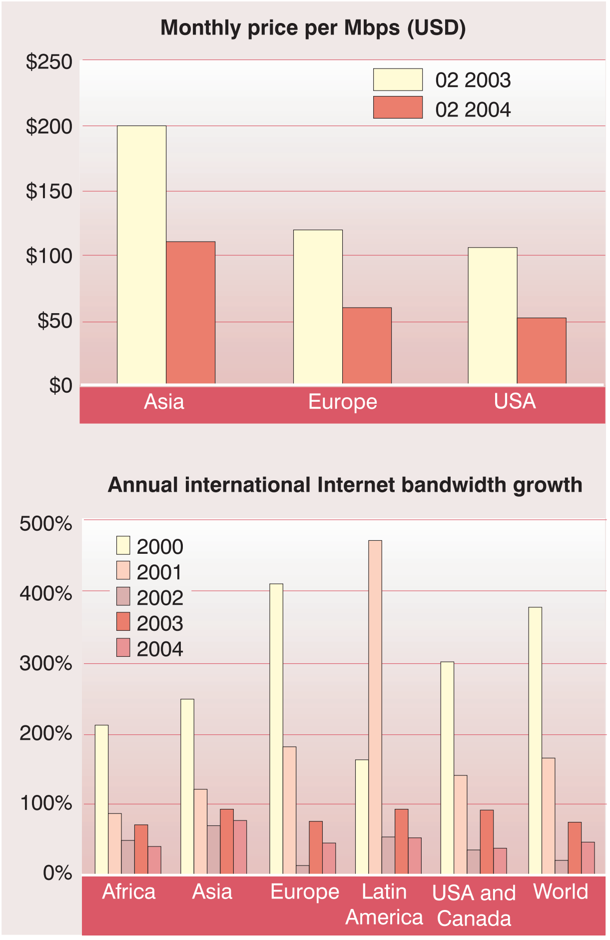
These trends are reinforced by the evolution of technology. Drawing a comparison with the historical evolution of the transport industry, Odlyzko (2004) points out the role of technology in reducing costs in the core of the Internet and how the logical and economically efficient outcome of the process for NSPs is to become suppliers of a commodity with a uniformly high-quality service. This trend is strongly reinforced by the degree of competition on major long-distance routes and the lack of a player that might have a chance to monopolize fibre optic cable supplies. When operators decide whether to exchange traffic on a peering or transit basis, this does not happen because of regulatory mandate, or because of lack of infrastructure. Rather, such deals are concluded if and when a valid business case can be made for them. Equally important is the fact that operators enjoy greater control over the factors that determine the level of quality of the service they deliver to their customers.

2. The developing world

The decline in bandwidth prices and the increase of international bandwidth availability in recent years and in all regions of the world are two major features of the environment in which the question of the international Internet connectivity of developing countries should be considered (see chart 2.5 and table 2.2) Although these trends cannot by themselves be taken as evidence of the existence of a perfectly competitive market for international Internet connectivity services, not least because of the secrecy in which commercial connectivity arrangements are shrouded, they seem to indicate that, at least in the heavier traffic routes, the most evident signs of lack of competition are absent. As some players find themselves unable to survive in such an environment, a consolidation process is under way and some providers may withdraw from the Internet transit market in certain areas, or even leave the business. In 2004 and 2005 this has combined with a strong increase in bandwidth demand, resulting in a slowing down in the fall of bandwidth prices.[37]

However, one should not overlook the fact that the smaller, low-income Internet markets in developing countries, particularly in Africa, have been unable to attract sufficient investment in infrastructure, which – combined with lack of competition – results in bandwidth cost that can be up to 100 times higher than in developed countries.[38] In most cases, these countries remain outside the reach of fibre optic cables, and must turn to satellites for international – and sometimes even domestic – connectivity. In spite of the significant improvements brought about by technolo-

Chart 2.5
International bandwith prices and growth



Source: OECD (2005), quoting Primetrica

gies such as Very Small Aperture Terminal (VSAT) satellites, the costs of satellite capacity is in an order of magnitude higher than that of fibre optic cable.

A key consideration for developing countries is the extent to which the experience of operators in developed countries, which was outlined in the preceding section, is relevant to the conditions under which developing countries connect to the global Internet. On the one hand, it can be reasonably argued that operators from developing countries may find it difficult, or even impossible, to implement the kind of strategies that were followed by their counterparts in developed countries in order to enhance their connectivity, for example capacity swapping. It may also be the case that the conditions under which the backbone market was considered to be a competitive one are not present in developing countries because of the existence of market failures that may justify regulatory intervention in the market for international backbone connectivity.

On the other hand, one should consider whether the removal of restrictions on Internet access markets would not provide incentives for operators in developing countries that would be comparable to those that have driven the changes in commercial arrangements and infrastructure deployment in the more developed markets. The experience of a number of developing countries indicates that by lifting restrictions on the provision of Internet backbone services, connectivity costs may be cut down and infrastructure deployment accelerated. For example, in India, where liberalization has already progressed, international backbone connectivity has exploded – and this has had positive effects for the development of Internet-based activity in that country. In other countries restrictions affecting the provision of international connectivity, such as making it compulsory for ISPs to use the international gateway of the incumbent operator, or restrictions on the availability of international leased lines, have been said to partially account for differences in bandwidth costs among countries in the same region:[39] for example, in May 2003 the monthly cost of 1 Mbps of international bandwidth in Singapore was of $1,300, while in Thailand it was $4,500.[40] Another example is provided by South Africa, where in a document released in March 2005, an association representing the country's ISPs complained that "at present, Telkom's monopoly over the SAT-3 cable, and the high prices Telkom currently charges to other telecommunications service providers for access to this cable are perhaps the single greatest contributor to the high costs of Internet access in South Africa".[41]

The comments of the South African ISPs point to an important consideration. In the final analysis, the cost of international connectivity matters insofar as it is reflected in the total cost of Internet access, and is the variable that will have an impact on Internet take-up and on the development of an information economy in developing countries. One should therefore pay attention to the breakdown of total end-user costs. In the most common case, these can be divided in two parts: ISP charges and telecommunication charges. Total ISP charges will partly reflect the ISP's international costs and partly reflect other costs (licence fees, capital costs, salaries and profit). Global Internet connectivity cost will be only one of the components of the international costs of the ISP, the other one being the cost of any international private leased circuit it uses. A comparative study of six African and Asian

Table 2.2

International bandwidth availability in selected developing countries/economies (2000–2003)

Country/economy	2000	% change	2001	% change	2002	% change	2003
Benin	2	0	2	5	2	2138	47
Bhutan	1	100	2	0	2	182	6
Cambodia	4	71	6	100	12	50	18
Cape Verde	1	100	2	50	3	167	8
China	2 799	171	7 598	23	9 380	190	27 216
Côte d'Ivoire	3	106	7	194	20	105	40
Cuba	17	206	52	48	77	13	87
Djibouti	0	300	1	300	2	0	2
Egypt	31	797	275	168	735	56	1 148
Eritrea	1	96	1	100	2	0	2
French Polynesia	8	7	8	75	14	71	24
Hong Kong (China)	4 180	51	6 308	101	12 668	127	28 737
India	840	76	1 475	27	1 870	60	3 000
Iran (Islamic Rep. of)	36	344	160	244	550	82	1 000
Lao PDR	2	0	2	-10	2	0	2
Lesotho	1	95	1	2	1	-2	1
Macao (China)	106	13	120	113	255	99	509
Marshall Islands	1	0	1	202	2	0	2
Mauritania	1	0	1	1134	10	0	10
Mauritius	6	67	10	240	34	79	61
Micronesia	1	95	2	0	2	0	2
Mongolia	8	25	10	70	17	29	22
Myanmar	1	300	4	20	5	88	9
Pakistan	50	350	225	82	410	38	567
Paraguay	10	5	10	877	100	0	100
Rep. of Korea	2 268	332	9 800	76	17 207	144	42 000
Samoa	0	781	2	33	3	0	3
Seychelles	2	200	6	0	6	0	6
Solomon Islands	0	100	1	0	1	0	1
Somalia	0	0	0	1103	1	30	1
Sri Lanka	10	150	25	270	93	0	93
Suriname	3	33	4	200	12	275	45
Taiwan PC	2 136	238	7 228	105	14 790	204	44 923
Thailand	268	140	642	57	1 011	42	1 438
Turkey	578	7	620	83	1 132	94	2 200
Uganda	2	207	5	82	10	5	10
Viet Nam	24	42	34	321	143	626	1 038
Average change		**152**		**175**		**135**	

developing countries found that the share of global Internet connectivity in total end-user Internet access costs ranged from 39 per cent in the case of Cambodia, mainly owing to the small size of the market and the consequently low levels of bandwidth supplied, to 4 per cent in India, which has a large market with significant levels of competition. The average value was 15 per cent.[42]

One should not expect the paths followed by carriers in developing countries as they build their Internet business to be identical to those taken by their counterparts in developed countries. For instance, developing national infrastructure will probably have a higher priority than international links – and it is likely that increased competition will also bring about positive results in this area too. However, these two goals should not necessarily be regarded as being mutually exclusive. As competitive pressures drive down the cost of international bandwidth, some developing country operators may find themselves increasingly able to provide end-to-end services in those routes that are strategically more important for them. Furthermore, such ability is not merely a function of bandwidth prices. In a radical departure from the switched-circuit model of the past, in which capacity was available on a point-to-point basis, in today's more flexible environment some major international backbone providers can sell amounts of capacity that can later be allocated to various routes.

Lack of competition in domestic Internet markets often makes it difficult for developing countries to benefit fully from the possibilities offered by the changes in the international environment in terms of better international connectivity. For example, when ISPs in developing countries can create national or regional IXPs, they are able to aggregate traffic and thus give global backbone networks a greater incentive to interconnect their infrastructure. Transit arrangements can be negotiated under better conditions for carriers from developing countries and there are more possibilities for peering. In addition, technology now allows even distant ISPs to benefit from participation in IXPs.[43] However, in a repetition of the experience of the more advanced countries in the earlier phase of the development of the Internet, monopolies often oppose the creation of domestic and regional IXPs in developing countries. Where incumbents do not enjoy a legal or de facto monopoly over Internet services, they may succeed in their opposition to the establishment of IXPs by controlling basic telecommunications infrastructure in such a way that independent ISPs do not stand a chance as far as developing their business is concerned. For example, in many developing countries monopolies impose high prices on leased lines, this being a key component in ensuring that ISPs and large business users are able to connect to global and domestic backbones. The number of leased lines permanently connected to the Internet has been found to be strongly correlated with the number of ISPs, for some of which the cost of leased lines may represent up to 70 per cent of the total cost of services to their customers.[44] In other cases, unreasonable delays in the provision of the service are reported, and in the worst cases leased lines may simply not be offered by the incumbent.

In a more competitive environment new entrants into the ISP market, which would not have the option of extracting monopoly rents from international connectivity, should have strong incentives to make commercial arrangements that suit their interests and those of their customers. This is borne out by the fact that the majority of the developing countries first connected to the Internet when the commercialization of the Internet was already well under way. Unlike earlier entrants from developed countries, developing countries did not always use the services of providers based in the United States or connect in the first place to backbones located in that country. The results of an OECD study published in 2002 and covering the 110 countries which had fewer than five ISPs at that time showed that the companies that advertised the greatest number of routes to networks in those countries were headquartered in a variety of countries. First in the ranking was France Telecom, which provided connectivity to 29 networks. The second provider was Cable and Wireless, which connected networks in 23 countries, followed by Teleglobe, which connected networks in 15 countries. About one third of the countries had ISPs that were connected via more than one foreign backbone provider. Arguably, the structure of the Internet is no longer centred on the United States. Western Europe, and increasingly East Asia and the Pacific, tend to have more capacity for intraregional links than for connections with the North American region. These regional hubs replicate, on a smaller scale, the hub-and-spoke structure of the early, US-centred Internet.

In other words, the international Internet connectivity of developing countries is less and less dependent on links to one single country, and the geographical layout of networks is less and less a function of the country in which the network operator is headquartered. Because the global environment is one of increasing flexibility and more options, developing countries have an opportunity to facilitate Internet deployment – and consequently the development of Internet-supported business opportunities – by empowering their ISPs to make their own choices about the infrastructure and commercial modalities that are best suited to their business needs. Some will prefer to buy transit services from regional or global networks. Others may decide to cooperate with operators of similar size to aggregate traffic and thus gain leverage in their dealings with global providers. Yet others may find that there is a solid business case for building or buying their own end-to-end capacity.

This said, concerns remain about the situation in those developing countries, particularly the least developed countries and landlocked developing countries – most of which are also LDCs – that face bottlenecks due to very limited access to international backbone networks. For reasons both of the small size of their markets and the resulting limited opportunities for benefiting from economies of scale, and of geographical difficulties, it is unrealistic to expect that domestic liberalization on its own will be enough to bring the cost of Internet interconnection down to levels that enable a significant increase in Internet access by people and companies. International cooperation has therefore an important role to play in accompanying and supporting the commercial development of Internet connectivity in these countries.

Another aspect that will require further consideration is the development of mechanisms to protect smaller developing country operators from potential anti-competitive behaviour by large international NSPs. As noted before, the regulatory authorities in developed countries have at different times felt the need to look into the level of competition prevailing in the markets for Internet backbone services. Developing countries may need to strengthen their capacity to assess developments in this area and to explore ways to develop effective response mechanisms – including through international cooperation – should the need arise.

Developing country policymakers should also take into account the fact that the outcome, in terms of broader diffusion of the Internet, of the introduction of increased competition in the different segments of the Internet services sector is not indifferent to the timing and pace of the opening process, or to the level of competition in the upstream segment of the telecommunications sector. For instance, there is little possibility for new ISPs to start operating unless they have access to reasonably priced telephone lines.

D. The international dimension

1. In the ITU context: Recommendation D.50

The debate about the consequences for developing countries of the commercial arrangements concerning international Internet traffic has, to a large extent, centred on ITU-T Recommendation D.50, work on which has been carried out within ITU-T Study Group 3 since 1998. The first draft of the Recommendation, which was adopted in Geneva in April 2000, read as follows: "It is recommended that administrations negotiate and agree to bilateral commercial arrangements applying to direct international Internet connection whereby each administration will be compensated for the costs that it incurs in carrying traffic that is generated by the other administration."[45] Although the language of the Recommendation does not amount to anything more than a call for the sharing of the costs of bilateral international interconnection among the parties involved, substantial divergences emerged among ITU member States about its meaning and consequences.

Some developed countries and major international operators, who also tend to be major ISPs in developed markets, saw in the Recommendation an attempt to impose on the Internet a traffic-based settlement system that would replicate the accounting rate regime used for international telephony – of which they were also critical. It was argued that this would entail excessive regulation of the Internet, which by restricting the freedom of ISPs to negotiate interconnection agreements on the basis of their own commercial considerations would interfere with private investment decisions and result in non-optimal allocation of resources that would slow down the deployment of global bandwidth and the growth of global Internet connectivity.

Other countries, mostly developing countries from the Asia-Pacific region, but also including some developed countries such as Australia, whose position later evolved, took the view that what was needed was not to transpose the telephony model onto the Internet but merely to ensure that unobjectionable principles such as non-discrimination, transparency and cost-based be applied to all services. According to this interpretation, the Recommendation was not calling for government intervention but relied on commercial negotiations; it was also pro-competitive and supportive of the emergence of new ISPs worldwide because, under the arrangements in place, non-US operators were in fact subsidizing tier 1 NSPs, which at that time were mostly US companies. The subsidy appeared because the non-US operator had to pay the full cost of the international transmission capacity to the United States even though the capacity was made available – without charge – to US-based ISPs to send Internet traffic in the opposite direction. As a result, non-US ISPs faced unfairly high international interconnection costs, which in turn had an impact on the cost of Internet access for their customers.

The response from the other side was that although it was true that US backbone providers required ISPs from the rest of the world to acquire their own transmission facilities if they wished to connect in the United States, many of the US backbone providers had PoPs outside the United States. And non-US ISPs were free to build or buy their own US backbones if they wished, as the market for backbone services was open. It was also argued that the Recommendation was insufficiently inclusive as it considered only international leased line costs but failed to address the cost-sharing of more general aspects of Internet facilities (for example, the costs of domestic links or hubs).

The debate continued in May 2000 at the Cancún (Mexico) meeting of ministers from the Asia-Pacific Economic Cooperation (APEC) group. The discussions resulted in proposing to the meeting of APEC's finance ministers at their November 2000 meeting in Brunei an action programme that included language to the effect that:

(1) Government intervention was not needed in private business agreements concerning charging for international Internet services if they were concluded in a competitive environment. However, when there are dominant players or de facto monopolies, Governments should promote fair competition.

(2) Internet charging agreements between providers of network services should be commercially negotiated and, among other issues, reflect the contribution of each network to the communication, the use by each party of the interconnected network resources and the end-to-end costs of international transport link capacity.

In October of the same year, the ITU's World Telecommunication Standardization Assembly (WTSA), held in Montreal, adopted a compromise version of Recommendation D.50. The new text was adopted by consensus, although the United States and Greece formulated reservations. The revised text read as follows: "It is recommended that administrations involved in the provision of international Internet connections negotiate and agree to bilateral commercial arrangements enabling direct international Internet connections that take into account the possible need for compensation between them for the value of elements such as traffic flow, number of routes, geographical coverage and cost of international transmission among others."

Following WTSA-2000, Study Group 3 undertook additional analysis of the technical and economic aspects of international Internet connectivity and considered the possible development of general principles that could be applicable to commercial relationships in this field. Two Rapporteur Groups were created. The first one, on international Internet connectivity, was to work on the establishment of guidelines that could facilitate the implementation of Recommendation D.50. The task of the second Rapporteur Group was to investigate the possibility of using traffic flows as a main negotiating factor in the field of international Internet connectivity.

On the basis of proposals by those Rapporteur Groups, guidelines to complement Recommendation D.50 were adopted in June 2004[47]. However, the study on the traffic flow methodology has not concluded and work continues.

Study Group 3 has recognized that the high cost of the international connectivity between the least developed countries and the Internet backbone networks remains a serious problem. It has recommended that the donor community undertake special actions in this respect. These could include, for example, supporting and facilitating traffic aggregation and exchange at the local, national and regional levels so that less traffic has to be sent over intercontinental satellite or cable links between least developed countries and Europe or North America. The retention of local and national traffic would reduce the dependence of developing countries on international communications links.

The Study Group also pointed to the importance of supporting the development and use of the Internet as a means of bringing about economic growth and development in developing countries, and in particular in the least developed countries. The scarcity of human resources capable of using and producing local Internet content was recognized by the Group as another very important problem. Addressing the human resource problem was identified as a priority for existing or new economic and social development programmes.

2. Interconnection and peering in the WSIS process

Different matters related to the question of Internet interconnection costs were brought up by some developing countries in the context of the discussions on Internet governance that took place during the first phase of the World Summit on the Information Society (WSIS), which was held in Geneva in December 2003. The final text of the Plan of Action refers to the question in paragraphs 9 j) and k) with language calling for the reduction of interconnection costs through the creation of regional backbones and facilitation of the creation of IXPs, and for commercially negotiated Internet transit and interconnection costs to be "oriented towards objective, transparent and non-discriminatory parameters".

The Summit decided that discussions on the question of Internet governance should continue, so as to prepare the ground for decisions that should be taken the second phase of the WSIS, scheduled for Tunis in November 2005. The Summit also requested the Secretary-General of the United Nations to create a Working Group on Internet Governance (WGIG), which should present the results of its work in a report "for consideration and appropriate action for the second phase of the WSIS in Tunis 2005". The tasks of the Working Group include developing a working definition of Internet governance, identifying the public policy issues that are relevant to Internet governance, and developing a common understanding of the respective roles and responsibilities of Governments, international organizations and other forums, as well as the private sector and civil society of both developing and developed countries.

The WGIG prepared a number of working papers in order to develop a common understanding of the issues and to facilitate its work. The papers were made public for comment at the WGIG's site. One of them, entitled "Peering and interconnection", addressed international backbone connectivity.[48] The paper, which for the most part is a factual account of the international discussions held so far on the matter, elicited less comment than for questions such as the governance of the domain name system, the reform of ICANN and control over the root servers. The question of interconnection costs was nonetheless identified in the group's final report as one of the priority public policy issues relevant to Internet governance.[49] The report includes a number of recommendations with regard to (a) the need to conduct research into possible alternative solutions; (b) a call for WSIS principles of multilateralism, transparency and democratic process to be reflected in the treatment of the problem; (c) an invitation to international organizations to report on the issue in the framework of whatever body, forum or mechanism for Internet governance and coordination that may be established by the WSIS; (d) a call for funding for initiatives to enhance connectivity, IXPs and content creation in developing countries; and (e) "building on international agreements", with interested parties being encouraged to "continue and intensify work in relevant international organizations on international Internet connectivity issues". The majority of these recommendations address more the need to build regional backbones, and the role of IXPs in reducing Internet access costs, than the establishment of international corrective mechanisms to the central issue of interconnection agreements between NSPs and developing countries' providers. This outcome is a reflection of the variety of views held on this question by different countries and other stakeholders, and could indicate that the status of the question of Internet interconnection, and in particular the implementation of ITU Recommendation D.50, may not undergo significant changes in the near future.

E. Policy options and proposals

The previous paragraphs show the difficulty of settling, in a general way and for all developing countries, the question of whether the commercial arrangements that currently determine the financing of the cost of international backbone connectivity are biased against developing countries. A related question to be addressed, and probably a more important one from the point of view of development, is the extent to which action at the international and national levels can be undertaken to effectively enhance access to the Internet in developing countries through interventions aimed at changing the results of the commercial decisions that now define international backbone connectivity.

The need to monitor competition in markets

Because those commercial decisions can reasonably be assumed to have been taken in a competitive environment – with the important qualification that in the case of some LDCs and small developing economies market failure may indeed be a problem[50] – it can be argued that *ex-ante* regulatory intervention in the market for international backbone connectivity would not be likely to bring about significant improvements in terms of the cost of access to the Internet in developing countries. This said, it would appear to be important that vigilance be exercised so that market structures do not evolve in a direction in which powerful market players can engage in anti-competitive practices. Regulators in developing and developed countries should also explore ways to cooperate in order to promote greater transparency concerning the dealings between developing country operators and global backbone providers, so as to prevent anti-competitive practices in the establishment of peering and transit arrangements. Requiring NSPs to make public the criteria they apply in order to decide whether to peer with other operators – as many already do – could be a useful measure in this regard. Greater transparency concerning prices and other aspects of the commercial transit arrangements reached between backbone providers and ISPs should also be facilitated. This would be particularly important in respect of their dealings with players from developing countries. Furthermore, efforts should be made to improve the availability of information about the quality of service provided by NSPs, as this can be used as an anti-competitive weapon. The identification and development of adequate grievance redress procedures that could be used in response to potential anti-competitive behaviour in the market for Internet backbone services could also be useful.

Domestic factors affecting international connectivity

Research indicates that ISP costs generally account for less than half of total Internet use cost in most developing countries, with the greater portion corresponding to telecommunications costs. As previously noted, not more than 20 to 35 per cent of total ISP costs have been found to correspond to international connectivity (with exceptional situations in some landlocked and LDC countries).[51] The most important factor that affects this international element of the cost of connectivity is probably the size of the market, as this determines whether investment in fibre optic infrastructure is economically viable or not – although general considerations about the attractiveness of the country or region for international investment may also play a role. As noted, economies of scale imply that the amount of capacity that is bought from international NSPs also plays an important role, hence the usefulness of traffic aggregation. Neither of these two factors is susceptible to change through direct policy action at the national level. This is not always the case of other factors that influence international cost, such as whether ISPs are allowed to buy international capacity directly, the price of international leased circuits and the relationship between ISP and international capacity providers – for example, whether the incumbent telecommunications operator also controls the ISP market, or whether independent ISPs are required to use the incumbent's international Internet gateway.

At the same time it cannot be denied that the organization of Internet traffic in many developing countries, insofar as it often requires unnecessary international segments, does impose wasteful costs on Internet users. There are real benefits to be gained by addressing these issues.

Developing countries have at their disposal a number of policy options that would allow them to significantly lower Internet access costs through national measures. Lack of competition in the market for Internet services among ISPs, and, where these exist, domestic restrictions that ISPs must overcome in order to access the Internet backbone, represent a potentially highly productive area for policy intervention. The costs imposed on Internet users by monopolies or dominant operators, because of last-mile issues and of obligations to use their services for international interconnection, may be more significant than those derived from the international segment of connectivity. The Halfway Proposition, outlined in box 2.2, offers a good inventory of policy measures (developed by developing country ISPs themselves) that developing countries could consider adopting without the need to wait for regulatory developments at the international level.

Supporting traffic aggregation and exchange

An instrument that needs to be fully exploited is the development of local and/or national IXPs, where these do not exist yet or have only a limited reach.

Box 2.2

The Halfway Proposition

The Halfway Proposition was formulated by the African Internet Service Providers Association (AfrISPA) and presented to the Conference of African Ministers of Finance, Planning and Economic Development held in Johannesburg, South Africa, in October 2002.[1]

The aim of the proposal was to ≈articulate the root causes of high connectivity costs in Africa and to map out a strategy of how to tackle the problem∆ The paper argues that the current burden of international Internet connectivity is unfairly placed on countries in Africa and that the existence of these reverse subsidies is the single largest factor contributing to high bandwidth costs. It estimated reverse subsidies to amount to between $250 and 500 million per year. The authors considered that redressing the balance through regulation by the ITU was not the way forward and that it would be preferable to allow the process to be driven by the private sector.

According to the document, the requirements for a private-sector-driven process included the aggregation of traffic within Africa (through the creation of Internet exchange points and the emergence of regional carriers facilitating regional peering), the creation of ≈Digital Arteries∆that would carry the traffic regionally (through regional fibre optic infrastructure that would reduce the costs of regional peering) and internationally (through international fibre optic infrastructure to reduce the costs for backbone providers of establishing PoPs in Africa).

The document identified a number of players that should be involved in the implementation of this initiative: ISPs, grouped in AfrISPA, would ensure that domestic traffic stays at that level through cooperation in the creation of effective national IXPs; national regulators and policymakers should provide the required enabling environment. The African Telecommunications Union, the African Union and the New Partnership for Africa's Development (NEPAD) would ensure that governments provide the necessary enabling environment to allow national and regional peering to evolve quickly. They would also play a role in awareness raising and sensitization about the cost of international connectivity in Africa. Finally, the donor Governments were called on to provide financial support for the initiative.

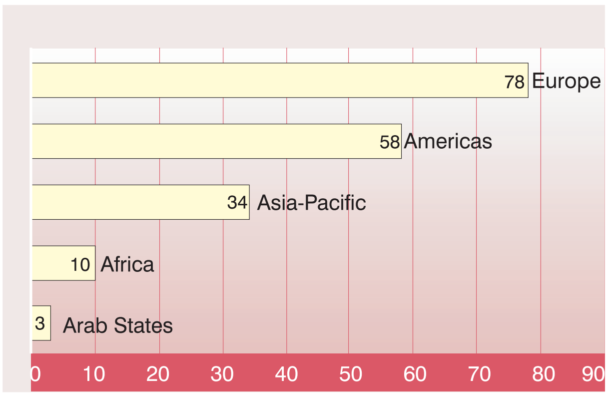
[1] See http://www.afrispa.org/Initiatives.htm

Chart 2.6 provides an image of the uneven level of development of IXPs across the various regions of the world. IXPs offer significant gains for developing country Internet connectivity in several regards, of which quality of service and the reduction of cost are perhaps the most outstanding ones as they refer to the two most commonly reported factors impeding the development of local Internet content and use. The establishment of IXPs in developing countries faces regulatory obstacles (limitations on non-regulated telecommunications infrastructure and on facilities, restrictive licensing, taxation issues), and the opposition of telecommunications incumbents and large ISPs (often also owned by the incumbent telecom), which fear the increased competition.

Policies to facilitate the creation of IXPs in developing countries should first create awareness among the Internet community – ISPs, large Internet users, universities, and so forth – so as to identify the relevant obstacles and the strategies to remove them. Associative efforts among ISPs aimed at the creation of the IXP should be supported, so that the IXP can be run efficiently and neutrally on behalf of participating ISPs. Also, it is important to bring on board the relevant government officials whose support will be necessary in order to address the legal and regulatory obstacles. Regulators should be particularly attentive to attempts by telecommunications incumbents to prevent the creation of new IXPs or suffocate those that already exist.

Chart 2.6

Number of IXPs per region, October 2004



Source: ITU (2004)

Where IXPs exist, policies should be put in place to facilitate their operation at the national level, and to promote cooperation agreements at the regional level. The reasons that make it advisable to support the development of national IXPs also apply to the creation of regional IXPs, which can help developing country operators to improve their bargaining power in their negotiations with global NSPs, and eventually aggregate enough traffic to be able to establish peering agreements rather than buying transit from them. The more serious difficulty for the creation of such regional IXPs is of course the varying levels of Internet development even among countries in the same region. Because of economies of scale, countries in which Internet markets are more developed tend to enjoy lower international access costs. These are sometimes even lower than the price that they would have to pay for the use of a common connection shared with a country with a smaller market. Countries with larger Internet markets therefore do not have an incentive to participate in a regional IXP, although the benefits of this in terms of quality of service (for example, reduced latency) could be significant. An alternative to regional IXPs may be the establishment of interconnection agreements between national IXPs of developing countries in the same region.

A competitive environment for ISPs

At the domestic level, it is important that Governments establish the conditions in which ISPs can operate in a competitive environment, thus reducing access cost and supporting the development of Internet markets. In such an environment, ISPs should be able to identify and negotiate the best commercial arrangements for international connectivity. In many cases, this process may be facilitated by helping ISPs to better understand the full range of international connectivity options open to them.[52] Assessing the appropriateness of each of them for their specific circumstances already represents a significant burden for many developing country ISPs, and capacity-building in this area could be a fruitful initiative for the international community to support.

Regulators in developing countries need to pay particular attention to ISP interconnection issues at the domestic level. For instance, it is important to ensure that new entrants are able to interconnect with other operators, particularly with the incumbent, quickly and at reasonable cost. It is also important that access to content be non-discriminatory regardless of the network access provider involved, and that network providers are free to choose their hosting providers. Quality is another aspect in respect of which interconnection among ISPs should take place on a non-discriminatory basis.

Another aspect in respect of which action taken at the national level can reduce Internet access costs concerns ISP licensing, which in many developing countries are subject to arrangements that represent an objective impediment to the development of Internet markets. Research suggests that countries requiring formal regulatory approval for ISPs have fewer Internet users and hosts than countries that do not require such approval.[53] Licence fees in particular should be examined. It is not uncommon that licence fees of ISPs are levied on the basis of the latter's turnover, this being equivalent to imposing a tax on the use of the Internet. Regulators should consider setting licensing fees at a level commensurate with the cost of regulatory activity, rather than regard such fees as a source of government revenue.

International and domestic leased circuits are another aspect in respect of which telecommunications policies should promote effective competition. In extreme cases the incumbent telecommunications operator may not even offer business users the possibility of leasing lines. In general, international leased circuits represent by far the largest component of the total international Internet connectivity cost faced by ISPs. The price for this is in the majority of cases determined or significantly influenced by the telecommunications incumbent, particularly if there is not long experience of competition in this segment of the market. In some cases, ISPs must buy international leased circuits and global backbone connectivity in a single package provided by the incumbent, normally at prices that are a multiple of cost. Giving ISPs more options for the purchase of international leased circuit capacity and eventually unbundling this from the purchase of backbone connectivity (transit capacity) should result in increased competition and lower prices. However, the fact remains that if ISPs of developing countries do not aggregate their traffic, the relatively low amounts of bandwidth they demand will mean that they will not be able to benefit from the more attractive prices available to those that buy higher-capacity volumes.

The role of VSAT satellites

While still considerably more expensive than fibre optic cable, VSAT satellites may offer another possibility of dramatically increasing the availability of bandwidth and reducing its cost, particularly in remote or sparsely populated areas. The cost of some of these terminals is now less than $2,000 and the monthly charges for Internet access could be as low as $150.[54] Potentially economies of scale could bring these figures down to $750 and $100 respectively. However, in many developing countries regulatory restrictions and high licensing fees (which can be as high as $15,000 per year/terminal for a 128 Kbps link) are inhibiting the deployment of VSAT.[55] Another obstacle preventing developing countries from fully benefiting from the cost-reducing effects of VSAT is the heterogeneity of applicable policies across neighbouring developing countries. Since many of these are small markets, investors may find it difficult to offer satellite services in just one or two countries, but the high costs involved in securing regulatory approval in several countries and the associated complexity introduce delays in the deployment of VSAT, add to the risk of the investment and increase the cost of deployment. The development of policy consensus among developing countries at the regional level concerning the regulatory requirements for VSAT operation would provide an incentive for the deployment of VSAT, bring down barriers to access for new entrants and thus result in increased competition in Internet access services and its attendant cost reductions and quality improvements.

These and other obstacles to the emergence of efficient ISPs may push companies to host their content overseas, as was documented in a number of cases in UNCTAD (2001). This has a cost in terms of lost e-business opportunities (for instance in the area of outsourcing), reduces the quality of service provided to domestic users and generally hampers Internet take-up among businesses. It also makes it difficult to implement strategies to cut connectivity costs such as the promotion of local hosting of local content and the caching of frequently demanded foreign content.

Regulatory capacity-building

The policy arsenal available to the developing countries in order to reduce Internet access costs seems therefore to offer significant possibilities for action at the national level. In addition to regulatory actions, in many developing countries policymakers could consider addressing institutional regulatory issues. Developing countries face severe shortages in regulatory capacity in a sector such as telecommunications in general and the Internet in particular, which is complex and fast-changing and in which the market conditions prevailing in developing countries often differ significantly from those in which the more widespread regulatory models and approaches evolved. These models often require levels of expertise and resources that are scarce in developing countries. Support for capacity-building in this area is therefore crucial. From the internal point of view, it is important that the regulatory authorities enjoy the political support that is needed to enable them to check the potential effects on market competition of the power that incumbents still wield as a result of their historical pre-eminence in the country's public sector.

The preceding considerations have stressed the importance of creating a pro-competitive environment in the market for Internet access in developing countries. Commercial arrangements, provided that abuses of dominant positions are prevented and traffic exchange is facilitated, should offer Internet operators the right set of incentives to invest in infrastructure, deliver lower-cost and higher-quality services, and increase connectivity in developing countries. However, in the final analysis, the fundamental reason why higher access Internet costs prevail in the developing world compared with the developed countries has more to do with low Internet penetration combined with the high costs of setting up terrestrial infrastructure from scratch, than with the concrete modality in which international backbone access costs are shared between ISPs and backbone providers. Small Internet markets make it difficult to generate economies of scale that could result in lower costs. Policy intervention in a number of other areas – the domestic Internet market, telecommunications, and other economic and social aspects of Internet access – stands a greater chance of starting a virtuous circle (higher use level generating economies of scale leading to reduced access cost and thus higher use) than *ex-ante* regulatory intervention in the market for international backbone connectivity.

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Notes

1. See www.unctad.org/ecommerce/ecommerce_en/events_en.htm.

2. A good summary of the critics' arguments can be found in the issues paper on peering and interconnection that was prepared for the first meeting of the Working Group on Internet Governance, convened by the Secretary-General of the United Nations as part of the preparation for the second phase of the World Summit on the Information Society. See www.wgig.org/docs/WP-Peering.pdf.

3. See the Internet Systems Consortium's Domain Survey, available at www.isc.org.

4. See Huston (2005) for an summary presentation of the implications of these differences for the possible financial arrangements for Internet interconnections.

5. Routers are specialized computers that forward data packets to their destination. Switches connect network segments.

6. Normally backbones use fibre optic cables that can carry between 155 Mbps and 9.6 Gbps.

7. Norton (2001).

8. There are no major functional differences between NAPs and IXPs. The term "NAP" originally referred to facilities in the United States designated by the National Science Foundation in order to provide for traffic exchange during the earlier phase of the commercialization of the Internet. NAPs were originally operated by telecommunications carriers. While in the United States NAPs are now generally operated by neutral, for-profit specialized operators or by non-neutral telecommunications operators, in many other countries the facilities performing traffic exchange functions are called IXPs, and tend to be operated by cooperative, non-profit organizations created by ISPs.

9. Telegeography Inc. (2005).

10. Gartner Inc. (2005).

11. According to research by Telegeography Inc. See Lightreading.com (2004).

12. Gartner Inc. (2004).

13. Lightreading.com (2004).

14. An autonomous system, in Internet terminology, is a group of networks controlled by the same entity (normally an ISP or a large organization), using a common internal gateway protocol for routing packets among them and a common external gateway protocol for routing packets to the rest of the Internet.

15. A rich literature has developed around the issues of peering, transit and interconnection. See, for example, Giovannetti and D'Ignazio (2004).

16. Bandwidth and latency are the two main determinants of the performance of a network. Bandwidth indicates the amount of data that can flow over the network by unit of time. Latency is the average time it takes for a data packet to travel across the network. While some latency is unavoidable, factors such as slow servers or complex routing can result in longer delays that seriously degrade network performance.

17. See, for example, the site of the London Internet Exchange at www.linx.net.

18. It should be noted that although no monetary payments are made, the exchange of traffic is not costless. Peering implies that the cost incurred by the two participating networks in carrying traffic from one network to the other and vice versa is approximately the same, but certainly not zero.

19. See Norton (2001) for an analysis of the conditions in which an ISP may choose to peer with another ISP.

20. Economides (2004b) illustrates this point with a simple numerical example: Network A has 20 ISPs with 5 websites and 500 users each. Network B has 1 ISP with 5 websites and 500 users. If all users have the same surfing habits and

all visit all websites, traffic from A to B will be 20 x 500 x 5 = 50,000 visits, while traffic from B to A will be 500 x 5 x 20 = 50,000 visits.

21. Various criteria may be used to assess similarity between networks, such as geographical coverage, network capacity, traffic volume, size of the customer base or position in the market.

22. Significant amounts of fibre optic remain “dark" as a consequence of past overinvestment, although some recent forecasts indicate that the “bandwidth glut" may start being absorbed in 2005. At the same time, technological development seems to ensure that the technical transport possibilities offered by fibre optic networks will continue to grow at a considerably faster pace than demand.

23. See, for instance, sites such as www.telegeography.com or www.itquotes.com.

24. See www.band-x.com.

25. Virtual NSPs do not own their own physical infrastructure, but buy unused capacity from other NSPs and market it under their own name.

26. The term “multihoming” refers to a computer host that has multiple IP addresses to connected networks. Addresses with different prefixes can be used to force traffic to be routed through different carriers.

27. Reliability and quality of service are other reasons for the increased popularity of multihoming.

28. Caching is the local storage of frequently accessed data, which reduces the need for data transfer over networks; mirroring consists in creating and maintaining multiple copies of websites or pages, often on different servers in different geographical locations; and intelligent content distribution technologies optimize data delivery by routing data-heavy web traffic using criteria such as bandwidth availability, distance and others.

29. See Economides (2004b).

30. See Odlyzko and Tilly (2005).

31. See www.isoc.org/standards for an explanation of the process of development and adoption of Internet standards and protocols.

32. If necessary, fibre optic not being used for Internet transport can easily be leased from other operators, and routers and switches are readily available at reasonable costs.

33. See Odlyzko (2004).

34. It should be noted that even today, and in spite of the large number of IXPs operating in Europe, some intra-European traffic may still be exchanged in the United States. Sometimes even traffic between ISPs in the same European country goes through US backbones. However, the reasons for this are purely commercial, as Internet traffic flows among developed countries are exclusively determined by commercial considerations and not by any infrastructure deficiency.

35. See United States General Accounting Office (2001).

36. See OECD (2002).

37. See Telegeography (2005).

38. See IDRC (2004).

39. The economies of scale generated by factors such as the numbers of Internet users or the geographical concentration of users also influence bandwidth costs.

40. See chart 1.5 of UNCTAD (2003).

41. See www.ispa.org.za/regcom/submissions/ispa-sub-proposed-interconnection-facilities-leasing-regulations.doc, p. 6.

42. See Antelope Consulting (2001). The countries involved were Cambodia, India, Nepal, South Africa, Uganda and Zambia.

43. An example of this is provided by the "Linx anywhere" system of the London Internet Exchange.

44. See OECD (2002).

45. In the language of ITU texts, the term "administration" refers to a telecommunications operator or Recognized Operating Agency (ROA).

46. See www.itu.int/ITU-T/studygroups/com03/iic/rapp.html.

47. See www.itu.int/ITU-T/studygroups/com03/iic/docs/TRECD50-0406Amd1E.pdf.

48. See Working Group on Internet Governance (2005a),. www.wgig.org/docs/WP-Peering.pdf.

49. See Working Group on Internet Governance (2005b), www.wgig.org/docs/WGIGREPORT.pdf.

50. This could refer to countries that remain beyond the reach of fibre optic cables and whose small Internet markets make infrastructure investment extremely difficult to sustain.

51. See Antelope Consulting (2001).

52. See Antelope Consulting (2001).

53. ITU (2004).

54. See IRDC (2004).

55. Ibid.