

CHAPTER 5. FROM CAPACITY TO CONNECTIVITY: NETWORK ACCESS AND INTERCONNECTION

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CHAPTER 5. FROM CAPACITY TO CONNECTIVITY: NETWORK ACCESS AND INTERCONNECTION

5.1. Introduction

Chapter 5 focuses on network access and interconnection as a basis for expanding connectivity. It explains why network access and interconnection are important and why they need to be regulated. Different forms of interconnection are defined and regulatory mechanisms such as unbundling and infrastructure sharing are examined. Interconnection pricing is discussed, including long run incremental cost modeling. The chapter also covers cross-border interconnection, the accounting rate system and international mobile roaming. It concludes with a look at new paradigms and challenges, such as the growing use of voice over IP.

5.2. Access and Interconnection

There are many situations in the ICT industry in which networks must be linked with each other in order to provide access to services for customers. This section first defines interconnection and then outlines the different forms it may take. The importance of interconnection and network access are then considered and the reasons why regulation

of interconnection is sometimes necessary are explored.

5.2.1. Defining Interconnection?

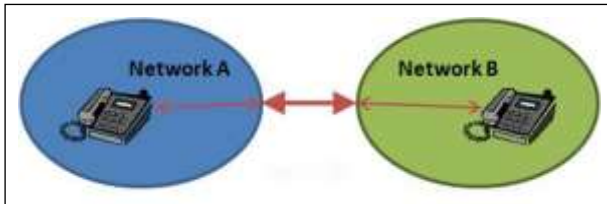
The World Trade Organization defines interconnection as:¹⁰

Linking with suppliers providing public telecommunications transport networks or services in order to allow the users of one supplier to communicate with users of another supplier and to access services provided by another supplier, where specific commitments are undertaken.

As technology has changed and competition has intensified, many forms of interconnection have evolved. All involve the linking of networks to enable customers of one network to communicate with customers of another network or to have access to services offered by another network operator. Examples of these different forms of interconnection are described below and shown in Figures 5.1- 5.6 (source: ICT Regulation Toolkit):

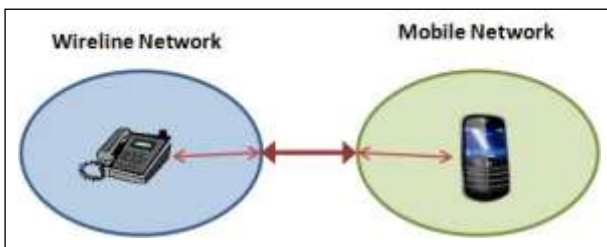
1. Two adjacent, non-competing telephone networks interconnect so that subscribers on one network can call those on the other (see Figure 5.1).

Figure 5.1 Adjacent Telephone Networks



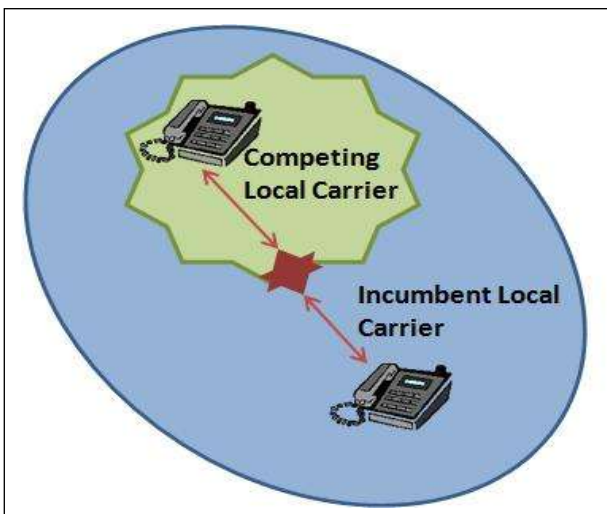
2. Traditional wireline telephone and new wireless mobile carriers interconnect so that subscribers of the traditional phone service can call wireless subscribers, and *vice versa* (see Figure 5.2).

Figure 5.2 Wireline Carrier and Mobile Carrier



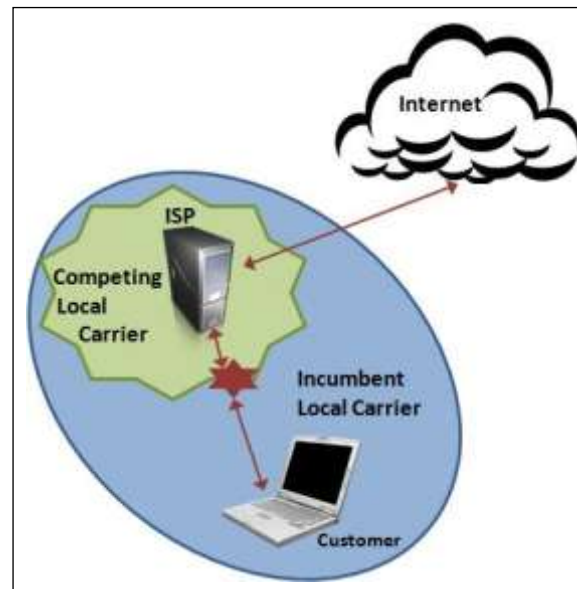
3. New competitive local telephone carriers interconnect with the incumbent carrier so they can attract subscribers in the common service territory, and enable those subscribers to call subscribers on the incumbent's network. Such competitive local carriers may also lease specific network elements from the incumbent (see Figure 5.3).

Figure 5.3 Competitive Local Carrier and Incumbent Location Carrier



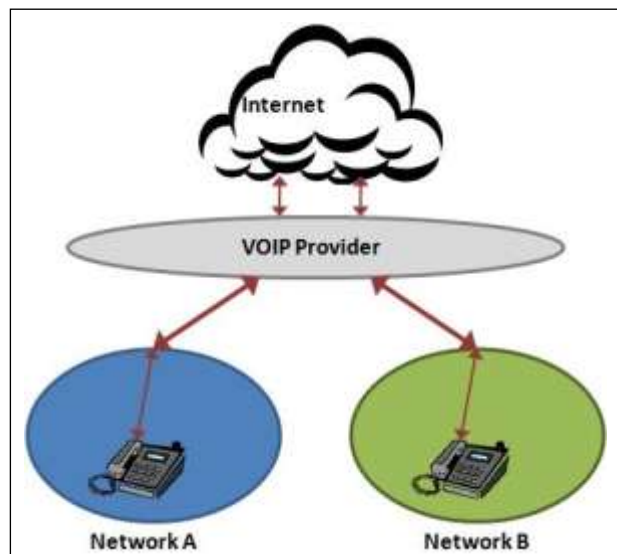
4. Customers of the incumbent telephone carrier make calls to their dial-up Internet Service Provider, which in turn is a customer of a competing local carrier (see Figure 5.4).

Figure 5.4 ISP Connected to a Competing Local Carrier



5. Firms offering a service in which part of the call is routed by Voice over Internet Protocol (VoIP) interconnect with traditional local service providers to complete the call (see Figure 5.5).

Figure 5.5 Competing Operator Routes Calls Using VoIP



Box 5.1 Interconnection Principles Contained in the WTO Regulation Reference Paper

This box outlines the principles applicable to interconnection that are contained in the World Trade Organization (WTO) Reference Paper (see Appendix A).

Section 2 of the Reference Paper addresses interconnection. Section 2.1 states that the interconnection provisions apply "to linking suppliers providing public telecommunications transport networks or services in order to allow the users of one supplier to communicate with users of another supplier and to access services provided by another supplier, where specific commitments are undertaken."

Section 2.2 of the Reference Paper states that interconnection with a major supplier must be "ensured at any technically feasible point in the network." This interconnection must be provided:

- on non-discriminatory terms, conditions (including technical standards and specifications), and rates;
- on a quality of service no less favorable than the major supplier provides for its own like services, the like services of its subsidiaries or other affiliates, or the like services provided to any other non-affiliated service supplier;
- in a timely fashion on terms, conditions (including technical standards and specifications), and cost-oriented rates that are transparent and reasonable having regard to economic feasibility;
- on a sufficiently unbundled basis so that the connecting supplier is not required to pay for network components or facilities that it does not require for the service it is purchasing; and
- upon request, at points in addition to the network termination points offered to the majority of users, subject to charges that reflect the cost of construction of additional facilities necessary to accommodate the request.

Pursuant to section 2.3, the procedures for interconnecting to a major supplier must be made publicly available. In order to promote transparency, section 2.4 requires that major suppliers make either a reference interconnection offer or its interconnection agreements publicly available.

The provisions on interconnection also include requirements relating to dispute resolution. Section 2.5 provides that an interconnecting service supplier must have recourse to an independent domestic body to resolve disputes regarding appropriate terms, conditions, and rates for interconnection within a period of reasonable time.

5.2.2. The importance of access and interconnection

ICT service providers need access to networks owned by others in order to provide services to their customers. Without interconnection, a customer cannot call subscribers on other networks or access Internet content located on another network.

Thus, networks interconnect with each other for a number of reasons:

- To provide a service that is not economically feasible without interconnection, e.g., calls to customers on another operator's network.
- To increase profitability. Where interconnection increases the value of telecommunications services, or the range of services operators can provide, it can be in the mutual interest of the operators to interconnect.
- To expand or improve services that are valuable to customers.

Interconnection has been important for telecommunications providers since the invention of the telephone. Even before competition emerged, adjacent carriers interconnected with each so that

their customers could make long distance and international calls.

With recent technological developments the range of services that depend on interconnection has increased. Interconnection is an essential element of local, long distance and international fixed voice calls, mobile voice and data services, satellite services, Internet access, e-mail and message services, broadband data transmission, and a wide range of multi-media services.

5.2.3. The Need for Regulation

Telecommunications operators will interconnect voluntarily in some circumstances. If two operators are not in direct competition with each other, then generally they will have an incentive to interconnect. This is because interconnection increases the value of a network to its subscribers, by increasing the number of people they can call and the range of ICT services they can access, the so-called network externalities argument.

Sometimes incumbent operators will have little incentive to allow access to their network, or to allow access on reasonable terms. Where the interconnection seeker is a potential competitor, an

incumbent may seek to limit competition, and preserve its market power, by:

- Refusing to interconnect,
- Offering interconnection at a price, or on other terms, that make it difficult for an efficient entrant to compete, or,
- Seeking to “sabotage” the entrant by providing a lower quality interconnection service to the entrant than the incumbent provides itself.

In these cases regulatory intervention is necessary. The motivation for interconnection regulation is that efficient competition in “downstream” markets would be difficult, or even impossible, unless entrants can access the incumbent’s network at appropriate prices, terms and conditions.

For example, the European Union’s 2009 *Better Regulation Directive*, which overhauled the 2002 Access Directive, empowers National Regulatory Authorities to impose on operators with significant market power obligations for access or interconnection in pursuit of competitive markets.

In any market, regulation needs to be able to adapt to changing circumstances. This is especially important in the ICT industry, where outdated regulation risks stifling market growth and innovation.

5.3. Forms of Interconnection

Here we introduce several key concepts in interconnection:

- One-way and two-way interconnection
- Unbundling, facilities sharing and co-location
- Asymmetric interconnection regulation.

5.3.1. One-way and two-way interconnection

There are two broad forms of interconnection: one-way interconnection and two-way interconnection.

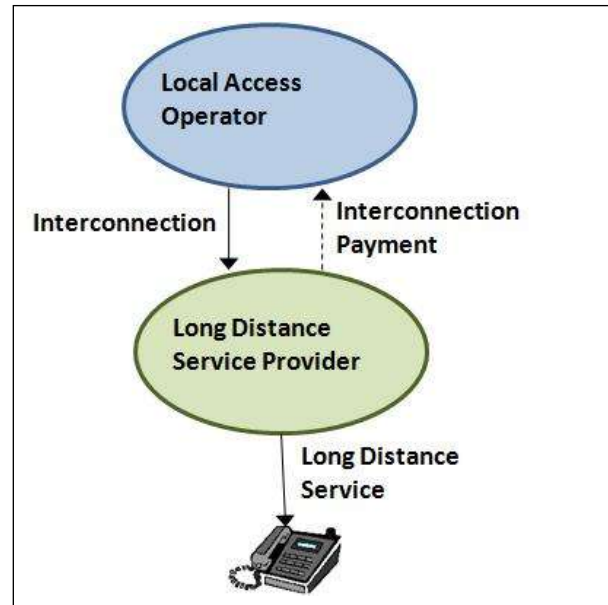
One-way and two-way interconnection can co-exist. For example, new entrants often obtain parts of their networks from the incumbent carrier (one-way interconnection), and then exchange traffic with the incumbent (two-way interconnection).

One-Way Interconnection

One service provider or carrier must obtain inputs from another carrier in order to offer services to its

customers (see Figure 5.6. The carrier supplying the inputs may or may not compete with the firm purchasing the inputs.

Figure 5.6 One-Way Interconnection



Source: ICT Regulation Toolkit.

For example, prior to 1996, local exchange carriers in the United States were prohibited from offering long-distance services. Long-distance carriers such as AT&T, Sprint and MCI obtained access from these local exchange carriers, to offer long-distance services to customers on the local exchange network.

Payment for one-way interconnection is always from the interconnecting operator (in the example in Figure 5.6, the long-distance carrier) to the interconnection provider (the local exchange carrier).

Two-Way Interconnection

In two-way interconnection, two or more carriers must connect their facilities (networks) so that customers of one carrier can call customers served by other carriers, and *vice versa* (see Figure 5.7).

Two-way interconnection also occurs in other industries. For example, credit cards such as VISA and MasterCard are provided over interconnected networks of member banks and participating merchants. Cardholders, member banks and merchants pay fees to access a credit card network.

5.3.2. Asymmetric interconnection

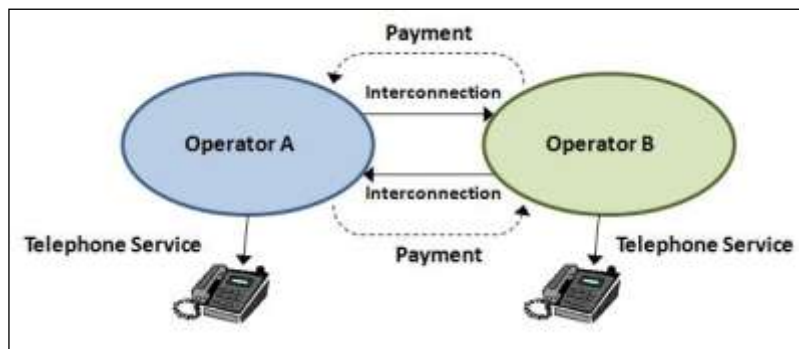
Interconnection regulation can apply equally to all telecommunications carriers (symmetric regulation) or to incumbent carriers only (asymmetric regulation).

Asymmetric interconnection regulation is very common. The rationale for asymmetric regulation is to redress the consequences of market power. Asymmetric regulation does this by placing

additional requirements on incumbent or dominant operators that might otherwise be able to prevent or deter competition.

For example, United States and Canadian regulators impose an interconnection obligation on all firms classed as telecommunications carriers. However, only incumbent firms are required to unbundle and share network components.

Figure 5.7 Two-Way Interconnection



Source: ICT Regulation Toolkit.

Asymmetric regulation can be useful in addressing existing imbalances in ICT markets. However, the need for asymmetric regulation should be kept under regular review. As market conditions change, new firms may enter the market, new competitive services may emerge, and market power can be eroded. Where this occurs, regulators need to reconsider the justification for asymmetric regulation and, if market power is no longer a concern, remove the additional requirements.

5.3.3. IP Interconnection

Traditional telecommunication operators are now moving beyond the public switched telephone network (PSTN) into IP-based, full-service networks, which are generally known as next-generation networks (NGNs). Telecommunication operators can use these NGNs to deliver a package of voice, data and video offerings, all using the same core network hardware.

Following the PSTN model, many operators want to control the entire network value chain – in other words, they want to build end-to-end networks, including trunking and access elements. This means that many NGNs are deployed with control and service-layer functions that resemble the closed systems of PSTN operations. These types of

networks can be referred to as the closed network model.

Meanwhile, many Internet service providers (ISPs) are also building broadband, IP-based networks that allow them to compete head-on with telephone operators by offering their own packages of voice (often VoIP), video and data. The ISP model, however, more closely complements and resembles the open Internet, with the “intelligence” and control of the network decentralized and powered by intelligent terminal equipment (i.e. computers, handsets or set-top boxes). This model, which can be termed the open network model, can be viewed as simply providing a more powerful, digital on-ramp to the existing (and growing) global Internet.

Currently we are at an evolutionary stage that features both models:

- The operator-managed, closed network model, which is successor of the legacy, public-switched telephone network (PSTN); and
- The ISP-derived, decentralized, open network model, which is an improvement on the best-effort IP-based network.

For regulators this raises several questions. Can these different types of networks coexist? Can they

interconnect? How will they evolve? The answers to these questions are important because of the value that can be unlocked through interconnection and the resulting ubiquity of information and content. It will be crucial to avoid a situation in which people are stranded on legacy networks that can carry only voice – while high-value customers shift to broadband IP networks. Similarly, regulators will want to avoid a perpetual NGN monopoly operated by an incumbent that will not interconnect with, or provide access to, ISPs.

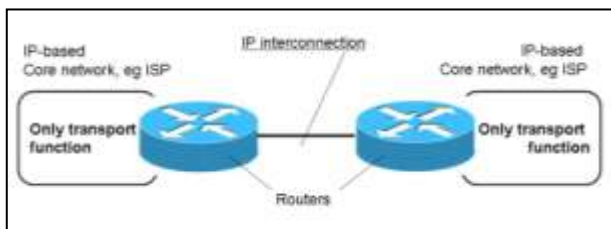
Interconnection between Best-Effort IP Networks

When describing interconnection between IP networks we naturally point to interconnection arrangements that are taking place in the Internet environment, where IP networks were first introduced and interconnected.

To visualize the interaction between various protocols in packet-switched networks (including IP networks), it is common to refer to a layered model.

This allows one to envision the operation of the protocols occurring within each layer, as well as the functions that occur at each layer. The TCP/IP suite of protocols is the most widely implemented among IP networks (see Figure 5.8). ISP networks are classical examples of IP networks that are based on the TCP/IP model.

Figure 5.8 Interconnection between Packet-Switched Networks



Source: GSR, Coexistence of Traditional and IP Interconnection, 2009.

Routers perform just a transport function, so interconnection between those network elements ensures connectivity between two networks, without any reference to the services that may be provided over the point of interconnection. Provision of IP interconnection, therefore, may be considered both “connectivity oriented” and “service-antagonistic”. When negotiating IP interconnection, ISPs consider only transport specific performance objectives (for example, delay or packet/loss ratio). Service provision and connectivity are fully separated within

the TCP/IP model – a separation that is easy to see in practical terms on the Internet. Because different services may be provided over IP-based networks, those networks are not considered service-specific and are usually referred to as open networks.

In contrast to open, IP-based networks, PSTN networks have service and transport layers that are closely linked. Here, interconnection is implemented with the idea of providing a particular service, such as voice telephony. PSTN networks, therefore, can be termed “service-specific” because they are designed to provide particular services. Compared with the Internet, independent introduction of third-party services to PSTN end users is difficult, if not impossible; hence, legacy telco networks are usually called closed networks.

Interconnection between IP-based and PSTN networks

With the emergence of Voice over IP (VoIP) service, IP-based network providers are now able to compete with telco operators in offering voice services. Because both telco and IP-based networks use different technologies, however, they cannot be interconnected directly. As of today, those networks are interconnected through two intermediate elements that ensure voice and signaling translation: media gateways (MGWs) and signaling gateways (SGWs). Both MGWs and SGWs are usually incorporated into one piece of equipment, often known as simply a gateway. Gateways are owned by one of the interconnected operators -- usually the operator of the IP-based network. The use of gateways has essentially resolved interoperability challenges, making interconnection between telcos and IP-based networks widespread.

5.3.4. Unbundling

In this section the question of network is explored and several key questions are addressed:

- What is unbundling?
- Why should regulators require unbundling?
- How much unbundling should be mandated?
- What are the costs and benefits of unbundling?

What is Unbundling?

Unbundling is the mandatory offering by network operators of specific elements of their network to other operators, on terms approved by a regulator or sanctioned by a court.

Unbundling goes further than imposing an obligation on incumbents to offer interconnection services to entrants. It requires the incumbent to allow entrants to lease certain individual building blocks that make up a telecommunications network.

Unbundling of network elements allows competing operators to enter the market and roll out services with considerably less sunk investment in some or all components of a competing network, e.g.:

- A new entrant might initially install switches in central business districts only, and lease those components of the incumbent carrier's network needed to directly serve customers in other areas, or
- An entrant might lease just those network elements needed to offer competing retail services (such as DSL services). In this way the entrant can offer competing services to customers without duplicating all components of the incumbent carrier's infrastructure, and without simply reselling the incumbent's service offering.

Unbundling usually requires facilities sharing or collocation, where the incumbent operator houses the communications equipment of competing operators to facilitate connectivity, or permits entrants to share infrastructure such as cell-site masts, cable ducts, or telephone poles. One example of facilities sharing is the policy adopted by the Malaysian Communications and Multimedia Commission, whereby operators granted 3G licenses have agreed to share their infrastructure with mobile virtual network operators. Infrastructure sharing is intended to facilitate improved coverage and service by allowing operators to share the risks of investment in emerging markets in the utilization of fixed network assets (see Chapter 5.3.5). Unsurprisingly, operators are reluctant to share network assets that they view as strategic.

Nevertheless, countries that have opened up their basic service markets to competition tend to show higher broadband and Internet take-up. All regions have made progress in requiring unbundling with Europe and the Arab States leading the way (see Figure 5.9). In Europe, the countries with the fastest market growth are those that have effectively:

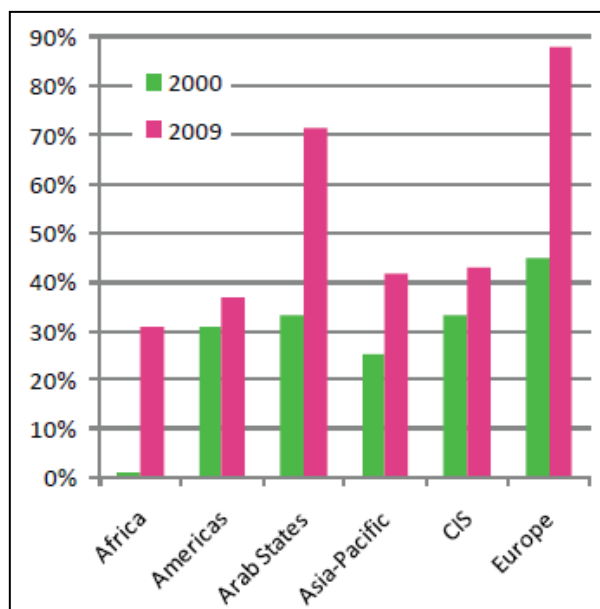
- Mandated unbundling (full unbundling, shared access, wholesale: bitstream and resale);
- Encouraged the provision of "naked DSL", as in the case of France; and

- Promoted alternative infrastructures, as in Denmark, Finland, the Netherlands and the United Kingdom.

Why Require Unbundling?

The rationale for unbundling is similar to that for interconnection regulation more generally. Some inputs are available only from certain network operators, and cannot easily be duplicated. Unless those inputs are available at appropriate prices, competition in downstream telecommunications markets would be difficult or impossible.

Figure 5.9 Requirements for Unbundled Access to the Local Loop



Source: ITU World Telecommunication/ICT Indicators database.

The emergence of competition from alternative technologies – such as wireless, cable telephony, and VoIP – is eroding this rationale for mandatory unbundling.

Unbundling can be an enormous task for regulators. The administrative costs of defining, and setting prices for, a range of network elements can be high. In addition, unbundling can impose high compliance costs on incumbent carriers. Regulators should carefully consider the merits of unbundling on a case-by-case basis, with a thorough assessment of the likely costs and benefits.

How Much Unbundling?

There are a range of options for unbundling interconnection services.

Under full **unbundling**, the incumbent must offer a separate fully unconditioned local loop service. This provides access to raw copper local loops, and subloops.

Under **shared access** the incumbent must provide access to the non-voice frequencies of a local loop and/or access to space within a main distribution frame where DSLAMs and similar types of equipment can be interconnected to the local loop.

Under **bitstream access for high-speed access** services, the incumbent must furnish and lease to other carriers links capable of providing high speed services.

The extent of unbundling has significant effects on the development and nature of telecommunications competition. If there is not enough unbundling, entry by efficient competitors may be inhibited. If there is too much unbundling:

- Entrants may focus on arbitrage opportunities, by obtaining services at attractive wholesale prices and reselling them to customers, instead of designing innovative product mixes that give customers greater choice
- Entrants may delay investing in infrastructure and focus instead on expanding re-bundled services as quickly as possible
- Incumbents may have fewer incentives to invest in unbundled parts of the network. This can lead to inadequate capacity, lower quality, and slower development of new technology (such as high capacity broadband).

Owing to the scale of the task, there has been a recent trend towards unbundling only those elements of a network that can be considered part of a natural monopoly. For example, In the United States, the Telecommunications Act of 1996 required all telecommunications carriers to

interconnect to exchange traffic. The Federal Communications Commission’s initial approach was to require incumbent local exchange carriers to unbundle extensively. It has since narrowed its approach to require unbundling of a more limited set of network elements. For example, incumbent local exchange carriers are no longer required to unbundle switching equipment (see Box 5.2).

Some jurisdictions require incumbent operators to only unbundle network components that are termed essential facilities, e.g., the Canadian Radio-television and Telecommunications Commission used the essential facilities approach when it required unbundling of local loops but not end-office switching, as switches were competitively supplied.

The ITU has developed guidelines for the West African Common Market that recommend that dominant operators (typically incumbent carriers with significant market power (SMP) should be required to provide new entrants with access to copper pairs (full local loop unbundling). The guidelines suggest that unbundling begin with shared access with full unbundling scheduled for a later stage. The guidelines also note that bitstream access may be an attractive option for ISPs because it does not require collocation.

Costs and Benefits of Unbundling

There is considerable debate over the costs and benefits of unbundling. Table 5.1 summarizes the potential costs and benefits, as put forward by regulators and incumbent carriers. The magnitude of these costs and benefits will vary depending on:

- The form of unbundling, and
- Whether regulated prices for unbundled network elements reflect economic costs.

Table 5.1 Benefits and Costs of Unbundling

BENEFITS	COSTS
Increases, and brings forward, entry by reducing entry costs Increases competition in the provision of services supported by the existing network Can bring forward the introduction of new services that rely on the incumbent's network technology (such as <i>DSL</i> services) and competition in those services	Potentially high administrative and compliance costs (costs increase with the extent of unbundling) May reduce incentives for incumbents to invest in new infrastructure. Enables incumbents to obtain legislative and regulatory relief, by making investment in NGN contingent on such relief May reduce incentives for entrants to invest in new infrastructure. Entrants may focus on reselling the incumbent's services, instead of designing innovative new service offerings

Box 5.2 United States: Unbundling - Revised Rules for Unbundling, March 2005

The FCC's original rules were the subject of ongoing litigation. After several court decisions that declared the FCC's unbundling rules inconsistent with the Telecommunications Act, in 2005 the FCC limited the number and types of elements that must be unbundled on a mandatory basis.

The new rules substantially reduced the unbundling obligations in several market segments, and adopt a more rigorous standard for determining when a requesting carrier is impaired. The new impairment standard focuses on the question of whether the absence of an unbundled element would impose a barrier to entry to an efficient competitor, which is large enough to make entry uneconomic.

In contrast to the original rules, the new rules severely reduced the number and types of elements that ILECs must unbundle on a mandatory basis. In particular, the FCC:

- Removed the mandatory requirement for ILECs to unbundle Fiber-to-the-Home (FTTH),
- Abolished line sharing as an unbundled element,
- Prohibited access to unbundled network elements (UNEs) for the exclusive service to mobile wireless services and long distance services, and
- Removed unbundled switching from the list of UNEs. This has the effect of removing the requirement that incumbents provide the UNE-P at TELRIC rates.

The most obvious effect of these changes is a substantial narrowing of the elements of the network subject to price regulation. This gives ILECs greater pricing flexibility. For example, ILECs now offer the equivalent of UNE-P at commercially negotiated rates.

The new rules also established a link between the duty to unbundle and whether alternative sources of supply are economically feasible. They do this by specifying a list of structural factors or impediments that regulators must consider when assessing whether a "reasonably efficient" competitor faces economic or operational impairment in a relevant market. These factors include scale economies, absolute cost advantages, sunk costs, first-mover advantages, and operational barriers within the control of the ILEC.

The new unbundling rules generally put an end to the initial country-wide unbundling rules for all network components in favor of more differentiated approach. Impairment analysis was to be done on a granular basis, i.e. taking into account market specific variation, such as disparities in customer classes, geography, service and the state of competitive deployment in the relevant geographic market. One important exception is the ordinary local loop, for which CLECs are generally viewed as impaired without access to such facilities.

Under the initial rules, impairments were restricted to the core services offered by CLECs in competition with ILECs. In contrast, the new impairment rules are applicable to any telecommunication service with the exception of mobile wireless services and long distance services. This change reflects the FCC's finding that workable competition has already developed in these markets, without access to unbundled network elements.

Sources: Vogelsang, 2005; Bauer, 2005.

Functional Separation

One possible safeguard is to require a "functional separation" for operators that are required to provide wholesale inputs to competitors. This means that separate business units with separate accounting are created for the firm's retail offerings and wholesale offerings. The wholesale business unit would sell to the retail business unit on the same terms and conditions as to competitors for the retail services. This idea could find application in situations where infrastructure competition is not likely to develop soon and, thus, the best hope for competition in the near term is service competition. The main advantage of a functional separation safeguard is that it would show clearly if the retail business unit was profitable while paying the

interconnection or unbundled elements charges that its retail competitors must pay. However, it may be possible to achieve this by less dramatic means, through the use of accounting or imputation tests to see if retail services are profitable. A disadvantage of functional separation is that the wholesale entity charged with operating the actual infrastructure that all competitors are using may not perceive itself to have strong incentives to invest in greater coverage and better technologies. However, this disadvantage may come more from the requirement to share network elements with competitors and not necessarily so much from the separation requirement itself. Broadly speaking, functional separation should be viewed as a last resort owing to the complexity and high cost of implementation.

Less radical solutions include accounting separation and operational separation.

One operator that has been required to implement functional separation is British Telecom with its Openreach subsidiary. Openreach's website describes the degree of separation it has from BT as follows:

- Separate disclosure of financial results
- No BT Group element to Openreach incentive plans
- Headquarters team in separate accommodation
- Introducing separate operational support systems
- Strict Code of Practice to be followed by all employees
- Strict rules about sharing information in an equivalent way with ALL Communications Providers
- Own identity (the Openreach wordmark)

5.3.5. Sharing Infrastructure

Infrastructure sharing is rapidly becoming an important means of promoting universal access to ICT networks and offering affordable broadband services by reducing construction costs. In light of under-developed markets and the high costs associated with network deployment, carefully

crafted sharing policy measures can introduce new forms of competition into the market and stimulate demand for ICT services.

There are a number of concepts that are central to understanding the policy and regulatory framework governing sharing. These concepts include: passive and active infrastructure; essential (or bottleneck) facilities; and open access. This section provides a brief overview of these concepts.

Passive and Active Infrastructure

There are several different elements of ICT network infrastructure that can be shared (see Table 5.2). However, not all elements of the network infrastructure can or should be approached in the same manner. In order to develop frameworks for regulating the sharing of network infrastructure, it is helpful to conceptualize infrastructure as falling into two categories: passive and active infrastructure.

The easiest shorthand definitions of passive and active infrastructure are as follows:

- Passive infrastructure includes all the civil engineering and non-electronic elements of infrastructure, such as physical sites, poles and ducts (and also power supplies).
- Active infrastructure covers all the electronic telecommunication elements of infrastructure like lit fiber, access node switches, and broadband remote access servers.

Table 5.2 Passive and Active infrastructure Sharing – Examples

	FIBRE CORE NETWORKS	MOBILE NETWORKS
Passive Sharing	Poles, ducts, power supplies	Electrical cables, fiber optic cables, masts and pylons, physical space on the ground, towers, rooftops, or other premises, shelter and support cabinets, electrical power supply, air conditioning, alarm systems, and other equipment.
Active Sharing	Lit fiber, access node switches, broadband remote access servers	The Node-B (the base station next to an antenna), Radio Network Controller

Essential or Bottleneck Facilities

Essential facilities, or bottleneck facilities, are network elements or services that are provided exclusively or predominantly by a monopolist or a small number of suppliers and that cannot easily be replicated or substituted by competitors for

economic or technical reasons. These types of facilities are critical inputs to retail service.

Open Access

Open Access means the creation of competition in all layers of the network, allowing a wide variety of

physical networks and applications to interact in an open architecture. Simply put, anyone can connect to anyone in a technology-neutral framework that encourages innovative, low-cost delivery to users. It encourages market entry from smaller, local companies and seeks to prevent any single entity from becoming dominant. Open access requires transparency to ensure fair trading within and between the layers, based on clear, comparative information on market prices and services.

Policy Issues

There are several policy issues associated with sharing. Some of the policy concerns relate to why sharing has become an important regulatory matter. These policy issues include:

- promoting rapid and efficient network deployment,
- the efficient rollout of next generation networks (NGNs), and,
- minimizing the environmental impact of ICT infrastructure and harmonizing network rollout with local land use planning.

Other policy issues relate to concerns about how sharing is implemented in the ICT sector. These policy issues include:

- preventing anti-competitive conduct,
- reducing wholesale interconnection and charges (which should in turn lead to lower retail usage charges), and,
- ensuring that sharing does not inhibit innovation in the ICT sector.

Promoting Rapid and Efficient Network Deployment

One of the most important policy concerns underlying the growing regulatory interest in sharing is the promotion of rapid and efficient network deployment. In many developing countries, the network in question is the mobile network, which is increasingly becoming the dominant form of infrastructure in these countries, as well as the backbone for the provision of universal access. In more developed and industrialized countries, the emphasis is on national broadband core and access networks and NGNs. Although the modes of sharing differ and although each network raises particular policy concerns, broadly speaking, sharing facilitates a rapid, less costly and less disruptive deployment of networks, whether the network is mobile, fixed broadband, or NGN.

Sharing helps to address three obstacles to efficient and timely network deployment: the high costs of network roll-out; restricted access to bottleneck facilities; and poor investment incentives, particularly in un-served or under-served areas.

Reducing the costs of network roll-out

Sharing can reduce the cost of network deployment. For example, in the case of mobile networks, civil engineering costs can mount up when the number of building sites is relatively high in the network roll-out. Site sharing allows operators to reduce their capital and operating expenditures. Lower site-development costs can pay dividends when they result in networks covering larger areas, increasing the likelihood of bringing wireless services to sparsely populated rural areas – and at more affordable prices.

Similarly, one of the most significant costs associated with the deployment of broadband fiber networks relates to the excavation of conduits and the installation of fiber for the access part of the network. This entails actual construction and installation costs as well as the cost of securing numerous permits such as digging permits and environmental permits. The shared use of ducts and poles, as well as other infrastructure, reduces an operator's physical deployment costs. Sharing is thus one dimension of creating an enabling environment for national core and access broadband networks.

Facilitating access to bottleneck facilities

The control of bottleneck facilities by a single dominant infrastructure operator tends to impede the development of new infrastructure, the expansion of competition, and market growth in general. The operator that controls these facilities (usually the incumbent) questions the commercial rationale for providing access to its infrastructure to its competitors. Mandated sharing of bottleneck facilities is a key strategy for opening up access to these facilities and thus for cultivating competition in downstream markets. Without mandated sharing, it is unlikely that incumbents would willingly offer access to their bottleneck facilities on commercially fair terms.

Low market investment

The high costs of deploying network infrastructure and low population density sometimes combine to impede investment in rolling out network services in rural and remote areas. In sparsely populated areas, the returns on investment in high capacity network

infrastructure are often too low to sustain commercial operations. Sharing can assist regulators and policy-makers address this problem in a number of ways.

First, as discussed above, sharing can reduce the cost of network deployment. Second, sharing can make a wider network roll-out more affordable which, in turn, creates a greater critical mass of users. In combination, the lower costs of network roll-out and the larger critical mass of users increase the return on expenditures, thereby generating incentives for investment. This is particularly critical when the costs of financing investment are high. In the case of un-served or under-served areas, policy-makers usually aim to create a greater critical mass of users by encouraging the roll-out of high-capacity, national infrastructure to a wider range of places than the market alone might initially sustain. Allowing two or more operators to share (and therefore to pay for access to) a common national infrastructure helps to finance a wider deployment, whereas traffic from a single operator would not sustain a widespread network.

Sharing, network deployment, and universal access

By facilitating quick and efficient network roll-out, sharing advances universal access policy objectives. In developing economies, sharing promotes network roll-out to un-served and under-served areas. In developed economies, sharing plays an important role in rolling out FTTx access and expanding broadband access to under-served areas, such as rural communities.

The Efficient Deployment of Next-Generation Networks

Sharing is increasingly playing a central role in the development and deployment of NGNs. The transition to an NGN environment requires significant investments as access providers and network operators must upgrade their equipment and build new network infrastructure (see Box 5.3). At the same time, convergence and the move to an IP-based network allow a variety of different types of services and applications to be provided over the same core and access infrastructure. Consequently, approaches to developing NGNs frequently feature the deployment of a single core network, with competition occurring in other layers of the network, such as the access, service, and application layers. Thus, these approaches typically are premised upon the sharing of the core NGN network

infrastructure and often feature sharing at other levels as well.

Box 5.3 Deploying Open-Access NGNs in Singapore

Singapore is rolling out wired and wireless NGNs by creating national core networks that are operated by a single company but that are also open to access by operators and service providers active in other layers of the network. Singapore's strategic plan announced in 2006 (the Next Generation National Infocommunications Infrastructure or "Next Gen NII") involves the creation of a wired, open access, and carrier-neutral Next Generation National Broadband Network (Next Gen NBN) and an open-access Wireless Broadband Network (WBN). The Next Gen NBN and the WBN are to be built, owned, and operated by the private sector. The government has made clear that the operation of the Next Gen NBN and WBN will involve structural separation of the operator of the passive network infrastructure, the operator of the active network infrastructure, and the retail services provider. The government of Singapore has indicated that it will provide various amounts of funding to the operators of the passive and active infrastructure of the Next Gen NBN and WBN. The funding is intended to kick-start the project and to ensure that the ultra high-speed broadband service provided over these networks will be viable, affordable and sustainable in the long-term.

Source: ICT Regulation Toolkit.

5.3.6. Mobile Networks

In many countries, mobile interconnection is regulated and priced differently, depending on the form of interconnection. There are three broad forms of mobile interconnection:

- Fixed-to-mobile interconnection: A mobile network terminates a call from a fixed network. The call might originate from a local fixed operator, a domestic long-distance operator, or an international operator,
- Mobile-to-fixed interconnection: A mobile operator interconnects with a fixed network in order to complete calls for the mobile operator's customers. Again, the fixed network might be owned by a local fixed operator, a domestic long-distance operator, or an international operator,
- Mobile-to-mobile interconnection: A mobile operator interconnects with another mobile operator.

Mobile Termination Rates

There is no a unique treatment of mobile termination charges among countries. Some countries only regulate mobile termination charges for fixed-to-mobile calls. In other countries, mobile networks are required to apply a single regulated termination charge regardless of where the call originates.

Calling Party Pays

Under Calling Party Pays (CPP) the calling party, or the calling party's network, pays for the call. The recipient of the call pays nothing.

CPP is used in many countries to structure interconnection payments for fixed-to-mobile calls. Under the “old” CPP model, the mobile operator sets a fixed-to-mobile tariff. The fixed operator deducts specified charges from this fee (such as an origination charge, and billing and collection charges), and passes the balance of the call revenue to the mobile operator.

In recent years, some regulators have decided to regulate fixed-to-mobile tariffs, rather than leaving this to the mobile operator to determine. This generally reflects concerns that fixed-to-mobile tariffs are too high. This concern has also led regulators to control mobile termination charges.

Receiving Party Pays (Mobile Party Pays)

A minority of countries, predominately developed countries such as the United States, uses a system of receiving party pays or mobile party pays for interconnection with mobile operators. Under this system, the mobile user pays airtime on received calls as well as calls that user has initiated. This reduces the problem of setting interconnection charges to defining the costs of just the link between two networks, which generally is low and easily defined. Thus, countries using receiving party pays have largely avoided the problem of high mobile termination charges. This is a definite advantage of the receiving party pays system. Since a receiving party pays system requires the mobile user to pay directly for network usage on the mobile network, its main disadvantage is that it makes it difficult commercially to extend service to mobile users with low income levels, precisely where the calling party pays system has been most successful.

Regulation of Mobile Termination Rates

Regulation of fixed-to-mobile rates and/or mobile termination charges is usually justified on the basis

that those prices are “too high” compared to a cost-based estimate, or to prices for outgoing mobile calls.

The premise is that mobile operators are able to sustain high fixed-to-mobile prices because they have market power in setting prices for fixed-to-mobile calls. This market power derives from the fact that the fixed subscriber who places a call to a mobile subscriber has no influence over which mobile network is used. Mobile subscribers make this decision when they decide to join a network. Under Calling Party Pays, mobile subscribers do not pay for fixed-to-mobile calls, so they may not take the price of these calls into account in selecting a network.

Many regulators now control mobile termination charges. There are several forms of such regulation:

- **International benchmarking:** In the absence of cost based data, regulators are increasingly relying on international benchmarking to set regulated mobile termination charges in their own countries,
- **Rounding:** Some regulators have introduced regulations requiring mobile operators to round each call to a lower unit of charging (for example rounding to the second when the charging unit is to the minute). The effect of this requirement is to reduce revenue from mobile termination,
- **Cost-based termination charges:** Regulators are increasingly pressuring operators to base mobile termination charges on long run incremental costs or fully allocated costs.

Other Pressures to Reduce Mobile Termination Rates

Market forces are also pushing down CPP rates and mobile termination charges. For example users are increasingly substituting mobile-to-mobile calls for fixed-to-mobile calls, creating additional pressure on mobile operators to reduce fixed-to-mobile rates and mobile termination charges.

United States’ international carriers, supported by the United States government, are pressuring developing country operators to reduce international mobile termination rates. Because United States carriers are net exporters of telephone traffic to developing countries, a reduction in mobile termination charges would reduce their net interconnection payments to foreign operators.

5.3.7. Negotiating Agreements

To achieve successful interconnection, the following issues should be dealt with in the interconnection agreement or by rule or order from the regulatory authority:

Prices and adjustment of prices over time. This includes the initial level of interconnection charges, a definition of the currency in which interconnection charges are to be paid (this is especially complicated when retail prices are set in a local currency and interconnection is set in another currency), and how prices will adjust over the term of the agreement to account for exchange rate changes and inflation. The “ownership” of the call must be defined. For example, in mobile-to-fixed interconnection, one possible mode is for the call to be “owned” by the mobile operator, who sets the retail price and pays for interconnection and billing and collection to the fixed operator. Another mode would be for the call to be “owned” by the fixed operator, who would set the retail rate and pay the mobile operator an origination charge. Liability for bad debt and uncollectable bills should be defined.

Points of interconnection. The physical locations where interconnection will take place and the technical standards to be employed in the interconnection should be defined. A process for requesting and obtaining additional points of interconnection should be established. This is closely related to the issue of transport charges and traffic routing.

Transport (conveyance) charges and traffic routing. Some definition must be made for how calls will be routed. In other words, if there are multiple interconnection points defined, the proper routing and hand-off point for each type of call should be specified – otherwise, higher charges may apply to misrouted calls. The applicability of transport charges in the receiving network for calls that must be carried beyond the area local to the point of interconnection must be defined. If one carrier has requested interconnection in a particular area so as to avoid paying the receiving network for transport charges, and the interconnection point is not made available, sometimes a virtual point of interconnection is defined for that location whereby transport charges are not collected to bring calls to that area.

Frequently, incumbent operators prefer to offer as few as possible points of interconnection so as to maximize transport revenues. However, over time, entrants usually wish to build out their own

networks and interconnect in more places so as to avoid paying the incumbent's transport charges.

Quality of service standards. Quality standards should be defined, particularly for time to provision circuits and for call blocking levels, and remedies should be specified should those standards not be met. Often, an incumbent provider will be required to provide at least as high a level of quality to interconnecting carriers as they provide to their own retail customers. Testing opportunities should be provided by each party.

Billing and collection. When and how to collect traffic data, when and how to exchange bills, and when and how to make payment should be specified. A process for reconciling traffic data and for making inquiries to the other party and for handling claims also should be incorporated. A procedure for resolving discrepancies is useful, which often involves seeking recourse to arbitration, the regulator, or to the courts.

Traffic measurement and settlement. Sometimes specific trunk groups are identified to carry different types of traffic so that each type of traffic can be billed for separately. However, these arrangements can be defeated and traffic could be disguised as the cheapest type of traffic. The responsibilities of each interconnecting operator to measure traffic need to be defined, as well as settlement procedures for when there are discrepancies over the amount of traffic measured. Obligations to cooperate in fraud detection and enforcement activities should be specified.

Numbering resources. Access of each operator to the country's numbering plan and numbering resources must be defined. It is particularly important that numbers be provided in a timely manner so that potential sales are not blocked. If number portability is to be part of the local regulatory regime, the terms of participation should be defined.

Forecasting network needs. Part of providing interconnection is having the available capacity to deliver and receive the traffic that flows between the interconnecting networks. To do so, a planning process must be followed between the interconnecting operators so that investment for additional capacity can be agreed, budgeted, and installed in time to meet the forecasted demand. Procedures to resolve differences over forecasts also must be defined as well as what constitutes a *bona fide* request for additional interconnection capacity.

At a minimum, a mutual obligation to notify the other party of network changes and upgrades well in advance is needed to avoid disadvantaging one competitor over another.

Access to customer information. By necessity, when completing calls and billing for them, interconnecting operators pass back and forth considerable information about each other's clients. Limits on the permitted uses of this information should be defined, particularly regarding the temptation to engage in marketing activities in approaching another operator's clients based on information obtained through interconnection activities. Safeguards are also necessary to protect customers' privacy.

5.4. Setting Interconnection Prices

5.4.1. Why is the Interconnection Price Important?

There is a consensus among economists and regulators that interconnection prices based on cost are most likely to lead to desirable outcomes. Measuring “cost” is challenging – there is no single correct interconnection price. However, if the interconnection price is set “too low”:

- Inefficient competitors may enter the market,
- Entrants may look for opportunities to profit by purchasing services at low regulated prices and simply re-selling them, instead of developing innovative new product offerings, and
- Incumbent operators may not invest in the network or maintain its quality.

For many new entrants, interconnection is one of their largest costs. If the interconnection price is set “too high”:

- It will deter entry by efficient competitors,
- In the case of two-way interconnection, carriers may concentrate on maximizing payments from other carriers, instead of focusing on providing services to retail customers, and
- Customers will be paying more than they need to.

Interconnection charges have generally been calculated by following either a paradigm of revenue sharing, or of interconnection usage charges. Revenue sharing means that the telecommunications operators involved in a call have agreed to share the

revenues, on a percentage basis or some other agreed basis. They thus share the risk of billing disputes and bad debts. On the other hand, interconnection usage charges imply setting charges to compensate explicitly one operator for the costs imposed on them by the other operator's use of their network to originate or terminate a call. The operator paying the interconnection usage charge “owns” the call and takes the risk of disputed and unpaid charges. In addition, retail charges may be in one currency and interconnection usage charges may be in another.

Interconnection Pricing Objectives

Access and interconnection prices have several possible, not necessarily compatible, goals.

In general, interconnection prices should promote economic efficiency, of which there are three forms:

- Allocative efficiency requires that resources, products, and services are allocated to the person or persons who value them the most. For this to happen, consumers of final products or services (such as telephone calls to other customers) should pay prices that reflect the cost of the resources used to provide those products or services
- Productive efficiency requires that market participants use scarce resources as productively as possible. This means that the most efficient provider should not be precluded from serving customers, and
- Dynamic efficiency requires that all firms (entrants and incumbents) should have proper incentives to invest in technologies that reduce costs and/or expand product offerings.

Some countries have additional objectives telecommunications, such as:

- Actively promoting competition, by making it easy for new entrants to obtain interconnection. This sometimes takes the form of low interconnection prices, to encourage new entry
- Achieving universal service. Many jurisdictions have historically maintained charges for basic telephone services that are below cost. This is to encourage widespread subscribership. Recently, some countries have mandated high charges for call termination by wireless carriers. The aim is to keep charges to wireless subscribers low in order to encourage rapid uptake of wireless services.

Interconnection Pricing Principles

There is a general consensus that, where possible, interconnection prices should be based on the additional cost to the incumbent from providing interconnection services. However, it is difficult to strictly align prices with the cost of interconnection.

Broadly, three broad principles, or “pricing rules” are used to set interconnection prices:

- *Incremental cost pricing.* Interconnection prices are based on the forward looking, long-run incremental cost of providing interconnection (usually TSLRIC or TELRIC). Incremental costs are estimated using a suitable cost model.
- *Retail minus pricing.* This approach starts with the incumbent’s retail price for the downstream service, and subtracts retail costs. The final interconnection price should also include any additional costs to the carrier that arise directly from providing interconnection services.

The retail minus approach, or more formally, the Efficient Component Pricing Rule (ECPR) can be defined as:

$$\text{Interconnection (Access) price} = \text{additional marginal cost of interconnection (access)} + (\text{Retail price} - \text{marginal cost of retail})$$

The ECPR results in interconnection prices that are higher than incremental costs. ECPR prices incorporate the opportunity cost to the interconnection provider of customers lost to the entrant. This includes any contribution to shared and common costs and any foregone profits. For this reason, ECPR is controversial. Although it does encourage productive efficiency, it does not necessarily support the goal of allocative efficiency.

- *Bill and keep.* Bill and keep only applies to two-way interconnection. With bill and keep the calling party’s network retains whatever revenue it raises through retail usage charges. Neither the calling nor receiving parties’ networks pay each other – the interconnection charge is effectively zero. One advantage of a bill and keep policy is that it can be adopted quickly without the need to employ a cost analysis. This may be useful, for instance, in the case of a small, developing country needing an interim policy to facilitate interconnection between competitors while developing a policy based on cost analysis.

When the traffic exchanged between networks is roughly in balance, the net payments in either direction would be relatively small, approximating the result of a bill and keep regime. Accordingly, bill and keep has sometimes been limited to situations where such approximate traffic balance occurs, with positive payments to the terminating carrier when traffic is not reasonably balanced.

Specific pricing and charging considerations vary between one-way interconnection and two-way interconnection. The pricing principles in these cases derive from the general pricing principles already described.

Pricing Principles for One-Way Interconnection

The interconnection price should give the interconnection seeker incentives to purchase interconnection from the upstream carrier where this is the least cost option (for the economy as a whole). For this, interconnection prices should not exceed the cost of providing interconnection.

If the interconnection provider is vertically integrated, and competes with the interconnection seeker, then the interconnection price should be set so that the most efficient downstream provider has a legitimate opportunity to compete successfully. (For example, the combination of interconnection and retail prices should not result in a vertical price squeeze.)

Economic theory suggests that access prices can be set to offset imperfections in retail price levels, for example by:

- Setting access prices higher (or lower) than interconnection costs when retail prices are above (or below) cost, or
- Setting access prices below cost in order to offset market power in the downstream market (where market power would otherwise lead to downstream prices that are above cost)

Pricing Principles for Two-Way Interconnection

As already indicated, interconnection payments for two-way interconnection can be structured either as Calling party pays (CPP), Receiving party pays (RPP), or Bill and keep:

Models of two-way interconnection are very complex, and conclusions about how to charge for

two-way interconnection tend to be model-specific. Which approach is optimal depends on a range of factors, including:

- Assumptions about the distribution of the benefits from the call between the calling party and the call recipient,
- Whether or not traffic between the two interconnecting networks is approximately in balance, and
- Differences in costs between the two networks.

Trade-Offs in Regulating Interconnection Prices

Setting interconnection prices requires trade-offs between the complexity of pricing framework, its accuracy (how closely price tracks cost), and transaction costs for affected parties. Theoretically, optimal prices vary significantly depending on the assumptions made in the economic model.

Governments and regulators need to be pragmatic about interconnection regulation for three reasons:

- The direct regulatory costs of a detailed forward-looking cost regime may be significant: operators may hire engineers, economists and lawyers to put forward their views; the regulator must have enough resources to assess competing claims about cost; and there may be costly dispute resolution processes
- As regimes increase in complexity, operators and potential entrants are more likely to focus on arbitrage opportunities than ways to offer consumers genuinely new services
- There is no guarantee that detailed cost estimation approaches will be accurate.

5.4.2. Long-Run Incremental Cost Modeling

The economic cost of interconnection is generally the starting point in establishing economically efficient interconnection prices.

In many jurisdictions, regulators set interconnection prices based on long run incremental costs (LRIC). (Examples include Australia, the United Kingdom, the European Union, and the United States.) The most common form of LRIC is Total Service Long Run Incremental Cost (TSLRIC), known as Total Element Long Run Incremental Cost (TELRIC) in the United States.

There are numerous methods of estimating LRIC. Approaches to modeling LRIC can be broadly categorized as bottom-up and top-down modeling approaches. Bottom-up models include scorched earth or scorched node methods.

“Bottom-Up” Modeling

Bottom-up modeling uses detailed data to build a hypothetical network that can supply telecommunications services, including interconnection services. The costs of this network, including capital costs and operations and maintenance costs, are then allocated to all the services provided. Bottom-up modeling has the following steps:

Step 1: Define the services to be modeled (for example local access services). This step includes gathering data on the number and location of customers in the geographic area under consideration

Step 2: Determine the design of the network — what facilities are required to provide the service, and where should they be located? A PSTN generally includes: wires and support structures that connect customers to telephone switches (loop facilities); end-office and high-level switches; and facilities that connect the switches (transport)

Step 3: Determine the amount of each type of equipment needed to construct the network

Step 4: Estimate the costs of each element. For each type of equipment multiply the amount required by its unit prices to arrive at the total investment cost. (TSLRIC models usually use current “best-in-market” costs)

Step 5: Convert the total investment cost, for each network element, into an annual (or monthly) amount. This amount equals depreciation costs and cost of capital for the firm in question

Step 6: Estimate annual (or monthly) operations and maintenance costs and non-network costs. This includes direct out-of-pocket operating expenses associated with the investment and indirect expenses, such as corporate overheads

Step 7: Estimate total costs for each network element by adding the annual (monthly) amounts calculated in Steps 5 and 6

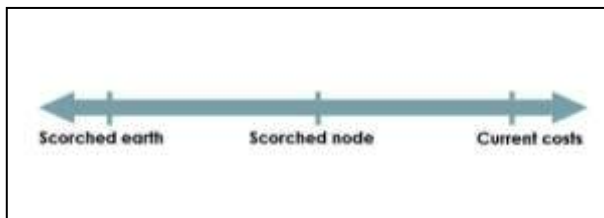
Step 8: Divide the total costs of each network element by the relevant cost-driver, to arrive at unit

costs. For example, use the number of lines to derive the unit costs for subscriber loops, or the number of minutes to derive unit switching costs.

“Scorched Earth” and “Scorched Node” Models

Designing the network to be modeled requires the regulator to make choices about how much optimization to include in the modeled network. These choices can be represented on a spectrum, as shown in Figure 5.10.

Figure 5.10 Approaches to Network Design in TSLRIC Models



Source: ICT Regulation Toolkit.

The scorched earth approach represents one extreme. It assumes that nothing is fixed, not even the location of the nodes. The scorched earth network is what an entrant would build if no network existed, based on the location of customers and forecasts of demand for services. This approach would give the lowest estimate of LRIC, because it removes all inefficiencies due to the historical development of the network.

At the other extreme, LRIC can be estimated from the current costs of the existing firm, using a top-down modeling approach. This will give the highest estimate of cost because it does not allow for optimization.

The “scorched node” approach to LRIC estimations represents a compromise between the two extremes. It assumes that the location of network nodes is fixed, and the operator can choose the best technology to configure the network around these nodes. Scorched node models are common internationally. Regulators in Australia, New Zealand, the United States, the United Kingdom, Austria, Switzerland, Denmark, the Netherlands, and Ireland have adopted the scorched node approach.

Regulators must make trade-offs between different objectives. Basing the estimate of LRIC on current costs would mean that entrants would pay more

than the efficient costs, potentially reducing entry. Basing the estimate on a scorched earth approach is also problematic. It could deter the network operator from making investments that are efficient given the actual configuration of the network, since the scorched earth approach ignores the existing network configuration.

“Top-Down” Modeling

“Top-down” modeling attempts to measure LRIC starting from the firm’s actual costs, as set out in its accounts. This method does not involve detailed network modeling. Instead, a top-down model separates the firm’s assets and costs into service groups, and then adds the costs associated with interconnection to arrive at an estimate of LRIC. This usually involves the following five steps:

Step 1: Identify the firm’s services and separate out interconnection services

Step 2: In the firm’s accounts, identify and separate all costs and assets

Step 3: If a cost item or asset is attributable to only one service, allocate it to that service

Step 4: Use allocation rules to allocate shared and common costs between services

Step 5: Calculate LRIC for each service by adding up the costs allocated to that services, including an appropriate return on those assets allocated to the service.

“Top-down” modeling uses the firm’s current operating costs and historic capital costs. These are not forward-looking costs. It is more difficult to take account of future changes in costs in a top-down approach than in a bottom-up approach that can incorporate explicit assumptions about technological change and its impact on the firm’s choice of inputs.

It is possible to make adjustments to top-down approaches to remove inefficiencies in the firm’s current network configuration and costs, but it is difficult to do so transparently. The incumbent firm will have more information about its historic performance and its accounts than the regulator or new entrants.

A comparison of the advantages and disadvantages of “Bottom-Up” and “Top-Down” Modeling approaches is shown in Table 5.3.

Table 5.3 Comparison of “Bottom-Up” and “Top-Down” Modeling

	BOTTOM-UP MODELS	TOP-DOWN MODELS
Advantages	Can model costs that an efficient entrant would face Flexible – can change assumptions readily Transparent – much of the information used is publicly available	Incorporate actual costs Useful for testing results from bottom-up model May be faster and less costly to implement, but this depends on how well categories in the financial accounts match the data required
Disadvantages	May optimize “too much” or omit costs. If this happens, the operator will be under-compensated and will reduce investment in the network Modeling of operating expenditure is usually based on simple margins instead of real-world costs Data needed for the model may not exist The modeling process can be time-consuming and expensive	Include the firm's actual costs, and so are likely to incorporate inefficiencies Less transparent – confidentiality issues mean other stakeholders may not have access to the information used The parties may dispute the cost allocation rules used (the rules used to allocate shared and common costs among specific services) Data may not exist in the required form

5.4.3. Benchmarking Interconnection Rates

Benchmarking has two main purposes in interconnection pricing. In situations where detailed cost models can be estimated, benchmarking can be used as a common sense check on the results of the modeling. Alternatively, benchmarking can be used directly to set interconnection prices.

Benchmarking is the process of establishing interconnection rates based on rates in other jurisdictions. For example, the rate charged to long distance carriers for terminating calls on a local network might be based on rates for this function in other jurisdictions.

Benchmarking can be useful to regulators if undertaken carefully. Undertaking a full forward-looking cost modeling exercise is challenging and time-consuming. In some markets the detailed information required may not be available. Regulators in many jurisdictions have used benchmarking to set initial interconnection rates (for example Botswana, New Zealand).

Where benchmarked rates allow competition to develop satisfactorily, rates based on benchmarking may be used for extended periods.

In a benchmarking exercise, adjustments need to be made for differences among jurisdictions, for example exchange rates, traffic patterns, or the cost of shipping network equipment.

5.5. Cross-border Interconnection

5.5.1. The Accounting Rate System

The accounting rate system was developed as a way to allocate revenue for international telephone services. The system is a series of arrangements between national operators in which the operators jointly provide international calls and divide the revenues from such calls between them. The accounting rate system provides a set of agreed prices for interconnection of international calls. The originating carrier charges the customer making the call a retail rate, and is charged the accounting rate for terminating the international call. As their name suggests, accounting rates do not always reflect costs.

If traffic flows along a route are balanced, the accounting rate system does not generate significant cash flows. However, for many less-developed countries, traffic on international routes is unbalanced — more calls are terminated in these countries than originate from them. As a result, the accounting rate system produced considerable revenue inflows to many less-developed countries.

Moving Away from Accounting Rates

The accounting rate system has come under pressure in recent years. The presence of competitive long distance providers has made it necessary for providers in other countries to deal with more than one correspondent. This has opened the gates to different arrangements, in search of lower prices.

Carriers can exploit numerous arbitrage opportunities to offer customers rates that are well below international accounting rates.

The system has also come under regulatory pressure. In 1997, the United States Federal Communications Commission acted to reduce these accounting rates by prohibiting United States-based carriers from paying rates above certain benchmark levels.

The accounting rate system has now been largely replaced by cross-border interconnection. Carriers directly negotiate rates to terminate traffic, in some cases with long-term contracts, in other cases on a short-term or spot basis. Electronic exchanges have emerged that enable trading of international voice, data, and mobile capacity. Arbinet is an example of such an exchange. Arbinet claims that a total of three billion minutes were bought and sold on its platform in the first quarter of 2010.

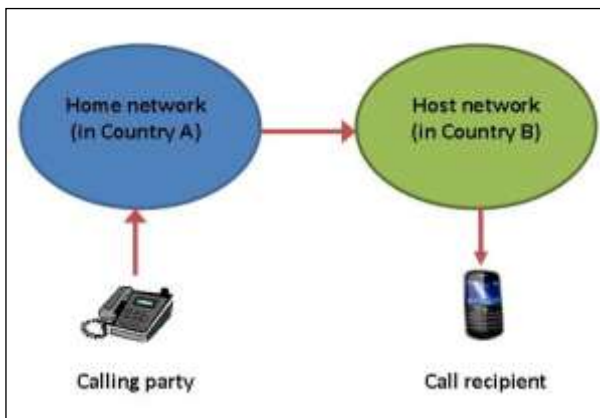
5.5.2. International Mobile Roaming

Roaming is the term used to describe the situation when a subscriber of one mobile operator's service travels outside that service area and obtains connectivity and service from another operator. Roaming can take place within a country or between countries, as long as it involves a customer of one operator being connected to the mobile network of another operator.

For example, roaming enables a subscriber of Cabo Verde Telecom in Cape Verde (which operates using GSM technology) to travel to Angola and obtain services from a GSM operator there.

Conceptually, roaming is similar to a call forwarding arrangement. Callers use their usual mobile phone number. The home network hands the call over to the host network, which passes the call to the customer's mobile phone (see Figure 5.11).

Figure 5.11 Mobile Roaming



Source: ICT Regulation Toolkit.

Roaming charges are generally much higher than termination charges within the home area. Customers often pay a monthly fee to be able to roam plus usage charges, the combination of which can be quite expensive.

For roaming to be possible, the customer's handset must be compatible with the host network. If the home operator and host operator use different technologies, roaming can only be accomplished using a different handset when in the host operator's coverage area. This can be expensive and cumbersome.

Even if network technologies are compatible, roaming cannot occur until the operators have agreed on the terms and conditions for accepting each others' roaming traffic. "Roaming agreements" between the operators establish the commercial and technical basis for implementing roaming.

5.6. New Paradigms and New Challenges

The ICT sector is developing rapidly. Technological advances are making new services, and new modes of service delivery, possible. In the future, the Internet will be the primary medium through which converging voice and data services will flow. As a result, market structure, business models, and commercial arrangements for interconnection are changing, as explored in the sections below.

5.6.1. VoIP

Internet telephony, or "Voice over the Internet Protocol" (VoIP), is a category of services that enable users to make real time voice calls, transmitted over the Internet (rather than using traditional circuit switched telephone networks).

VoIP enables network operators, service providers, and consumers to make significant savings, by:

- Reducing the underlying costs of a telephone call. VoIP uses network resources much more efficiently than conventional telephone service, reducing the costs of providing a call (albeit with the loss of some call quality and service features), and,
- Creating opportunities for regulatory arbitrage that enable service providers and consumers to reduce or avoid call charges and/or regulatory fees.

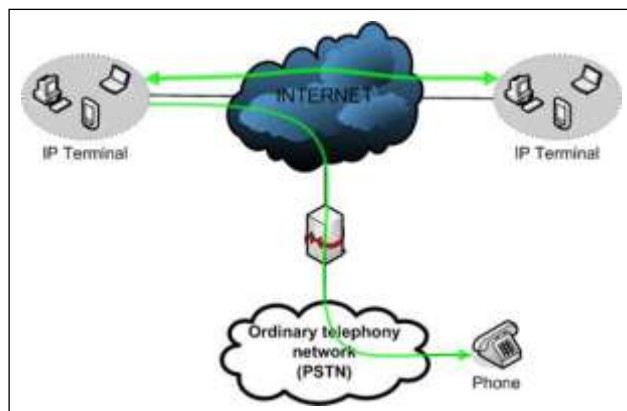
In 2010, the volume of VoIP traffic is growing rapidly and the potential exists for packet switched, Internet Protocol networking to become the primary medium for most voice and data services. The implications are that information services (including VoIP) will become the primary end user service provided by telecommunications networks.

Types of VoIP

VoIP services differ depending on whether (see Figure 5.11):

- the service provides a competitive alternative to conventional telephone services;
- a conventional telephone can transmit and receive calls;
- subscribers need to acquire and install additional equipment on their premises;
- traffic routes into or from the public switched telephone network (PSTN); and
- users pay for service.

Figure 5.12 Different kinds of VoIP



Source: ICT Regulation Toolkit.

Protocols that Support VoIP

VoIP uses a number of protocols to transmit voice calls using packet switching. The Internet Protocol (IP) is one of several processing standards for routing Internet traffic. IP ensures that traffic can reach the intended recipient even though it traverses different networks using different equipment.

Compression algorithms reduce the number of packets that must be transmitted by sampling the voice traffic and reconstructing a digital replica.

The Real Time Transport Protocol provides procedures for loading packet headers with routing, signaling, and identification information so that, for example, packets that arrive out of sequence can be rearranged.

The Session Initiation Protocol provides standardized call processing formats. This enables VoIP ventures to offer telephone service features from ringing and busy tones to call forwarding.

The Transmission Control Protocol manages the complete link of sender and recipient through different networks.

Comparison of VoIP and Conventional Telephony

A number of factors indicate that consumers increasingly view VoIP as “functionally equivalent” to conventional telephone service:

- Increasing numbers of consumers use VoIP as an alternative to conventional service. In making this choice, consumers are trading off a reduction in quality and some loss of features, for a lower price or for free.
- Improvements in VoIP service have reduced the difference in quality between VoIP and conventional service.
- Many carriers partially route calls over the Internet without their customers’ knowledge. In many cases, consumers are unable to detect differences in quality between VoIP and conventional service.
- VoIP customers can now obtain a telephone number and receive calls originated on the PSTN.
- There is evidence that local exchange telephony subscriptions, total switched long distance minutes, and revenues for conventional dial-up services are declining. This suggests that many consumers are switching to VoIP. A number of other factors may also contribute to this trend, such as migration from wireline to wireless services; the proliferation of private-line and virtual private-line services that can access the PSTN; and the commingling of voice and data services on the same telecommunications link.

Arbitrage Opportunities in the ICT Sector

Traditional network operators often charge different interconnection rates, depending on the type of call

or type of service provider involved. Often this reflects differences in regulatory treatment between service providers. This creates opportunities for service providers to engage in arbitrage (either legally or illegally).

Arbitrage can cause marketplace distortions and reduce the effectiveness of regulation. If legislatures and regulators do not promptly adjust the regulatory policy that triggered such arbitrage, the impact on the market can be substantial.

Not all regulatory arbitrage strategies violate laws and regulations even though they deviate from regulatory intent, or exploit loopholes. Also, when network operators create arbitrage opportunities in the absence of a regulatory obligation, or if they fail to close a loophole quickly once it is detected, this may indicate that they themselves expect to benefit. Operators will tolerate some loss of revenue if it is outweighed by other benefits, such as regulatory relief or compensation.

Certain features of VoIP traffic create additional arbitrage opportunities. VoIP traffic can readily enter the Internet without traversing the PSTN. Opportunities also exist for terminating VoIP traffic without traversing the PSTN, or through undetected transit of the PSTN. Even when a PSTN operator is able to detect VoIP traffic, it may not be able to differentiate between local, domestic, and international VoIP calls for billing purposes.

Arbitrage may involve:

- qualifying services as long-haul transmission in order to avoid universal service surcharges,
- obscuring the origin of traffic to making international traffic appear domestic and long distance traffic appear local, in order to obtain the most favorable access price,
- characterizing traffic as local instead of long haul, to generate a reciprocal payment obligation (instead of a one-way access charge),
- distorting or obscuring the origin of traffic and the method of transmission to reduce or avoid charges imposed by another carrier for delivering the traffic to the intended recipient, and
- offering telecommunications services as ancillary to, or a minor transport element for, an enhanced information service.

A number of arbitrage strategies are sufficiently common that they warrant specific mention:

- grey market strategies
- leaky private branch exchanges (PBXs)
- resale of private lines
- international call reorigination (or “call-back”)
- refiling, and
- routing calls over the Internet.

Implications of VoIP for Regulators

As VoIP becomes more similar to conventional telephony, VoIP providers will compete more directly with incumbent telecommunications operators. National legislatures and regulators will eventually have to decide what aspects of conventional telephony regulation should apply to VoIP service. Once a significant volume of telephone traffic is carried over Internet networks, the differences between VoIP and conventional traffic will have implications for universal service arrangements, telephone number management, public safety, and national security. For example, VoIP services are not available on a public, ubiquitous basis. In addition, they are generally unable to provide access to emergency service, or give location information in case of emergency.

VoIP presents a particularly compelling challenge to regulators. Decisions on the regulatory status, availability, and price of VoIP services will directly affect the economic viability and future regulatory status of incumbent operators.

VoIP has the potential to erode the market share and profitability of incumbents. VoIP services can traverse the telephone network without detection. Thus, even where regulators permit only limited or no VoIP services, incumbent operators will still face competition from this source. Incumbent operators may no longer be able to expect voice traffic to generate lucrative revenues and profits.

In response to this competitive pressure, incumbents may seek regulatory relief. For example, incumbent operators may approach regulators seeking:

- regulatory parity with new entrants, for example by removing asymmetric regulation not imposed on other operators; or
- protection from competition, for example, by banning or seeking to limit VoIP services.

Finally, regulators will have to consider how best to encourage incumbent operators to retrofit their existing networks and install new digital plant, optimized for switching and routing data (of which VoIP will be a significant component in the future).

Trends in VoIP Regulation

In many countries Internet telephony qualifies for streamlined regulation on grounds that it is an “enhanced,” “value added,” or information service (generally consistent with regulatory treatment of the Internet).

As VoIP becomes a closer substitute for conventional voice telephony, regulators may be less inclined to eliminate regulatory requirements. This is particularly the case where VoIP services are close substitutes for traditional telephony, for example where VoIP operators seek telephone number assignments and number portability.

Most countries that have developed a VoIP regulatory policy have adopted a light handed approach in general, and have targeted regulatory interventions to specific matters, such as access to telephone numbers, number portability, access to emergency services, universal service, and national security.

Differential Regulation of VoIP and Conventional Telephony

Many countries regulate information services and traditional telecommunications services differently.

Differential regulatory treatment creates opportunities for arbitrage. It also encourages incumbent network operators to:

- focus new investment on unregulated broadband networks, and
- migrate services (including voice telephony using VoIP) onto those new networks wherever possible.

This behavior achieves operational savings, and also qualifies voice telephony traffic for a lower level of regulation.

The result will be an increase in the volume of information services, and a reduction in the volume of voice telephony minutes of use that are subject to interconnection charges, or international accounting rate settlements. Network operators’ traditional sources of revenues will erode, forcing regulators to

rethink how network operators should be permitted to recover their costs.

Interconnection Pricing for VoIP

As network operators migrate to digital networks, voice services will become simply software applications riding over the network. Converging technologies and markets make conventional approaches to interconnection charging unsustainable.

Many technology forecasters predict that in the future voice telephony will migrate completely from circuit-switched telephony to VoIP. Once this happens, Internet interconnection and pricing models may replace the current arrangements. In the interim, VoIP network operators will need to interconnect with incumbent network operators’ PSTNs. This section addresses:

- differences in cost recovery between the Internet and conventional telephony;
- interconnection models by Internet Service Providers (ISPs), namely peering and transit;
- implications of VoIP for interconnection pricing;
- pricing mechanisms for VoIP interconnection; and
- criteria for a new interconnection pricing regime.

Comparison of Telecommunications and Internet Cost Recovery

Cost recovery models in telecommunications and for the Internet differ substantially. As technologies and markets converge, these differences are creating opportunities for arbitrage. This section compares the cost recovery models for telecommunications and Internet interconnection.

Models for Internet Interconnection

ISPs use different models for interconnection pricing, depending on the specific characteristics of the ISPs concerned. Broadly, ISPs can either:

- enter into “peering” arrangements; or
- enter into a transit arrangement.

Implications of VoIP for Interconnection Pricing

Changes in how telecommunications services are delivered, including the emergence of VoIP, will have significant implications for interconnection pricing. In particular, the opportunities VoIP creates for arbitrage create pressures to:

- move toward cost-based pricing for interconnection (and other telecommunications services), and,
- adopt uniform charges for access, regardless of the type of call, type of service providers, or other call characteristics.

Cost-based Pricing

Traditionally, telecommunications prices have been designed to keep prices for access and “basic” local service low, at the expense of long-distance users. The resulting high long-distance prices have created numerous opportunities for arbitrage, which have placed downward pressure on prices.

Recognizing that the traditional model is unsustainable and inefficient, many regulators are now moving towards a more cost-based model. This shift often involves a long transition period, to avoid significant immediate jumps in prices for basic service.

Generally, pricing reforms are accompanied by a shift to transparent funding of universal service obligations, through explicit charges to interconnecting service providers, or directly to end users.

Uniform Access Charges

It is common for network operators to charge different access prices depending on the type of call, the type of service providers, or the distance involved. This creates opportunities for arbitrage.

In many cases it makes more sense to move to a uniform charging regime. For example:

- Network operators, especially long-distance, average long- and short-haul traffic costs and charge a flat rate for calls (for example, a single per-minute rate for all calls in a wide geographic area – say, nationwide).
- “All You Can Eat” pricing – a flat monthly rate for unlimited local and long distance calls. This form of pricing is already standard for Internet access in many countries.

- If the cost of measuring the distance between the call originator and call recipient exceeds the cost difference in handling traffic of different distance, then network operators should not bother to do so. In this case, charges should not differ based on distance.

To move to a more sustainable charging regime, regulators will need to:

- eliminate regulatory asymmetries that treat similar services differently based on the technology used to provide the services (for example, VoIP or conventional voice service), or the type of provider;
- decide whether VoIP providers offering equivalent service to conventional voice telephony should pay the same charges and regulatory fees as other network operators.

Changes in technology and telecommunications network cost structures mean that per-minute pricing may become an inefficient cost recovery mechanism. As more services are delivered as packets over digital networks, minutes of use are no longer an important cost driver.

Technical developments are improving the ability of consumers to manage their own telecommunications services. As a result, the premise that the calling party is the sole cost causer may no longer be valid.

Pricing Mechanisms for VoIP Interconnection

This section discusses:

- the application of origination and termination payments to VoIP interconnection;
- cost drivers for VoIP;
- setting cost-based charges for VoIP interconnection; and
- reciprocal payment obligations between VoIP providers and conventional operators.

Application of Origination and Termination Payments to VoIP

VoIP providers require access to the PSTN to terminate calls to recipients who do not subscribe to the VoIP provider’s service, and for some types of call originations. Such interconnection typically occurs between a VoIP operator’s gateway and the PSTN operator’s Tandem Switch closest to the call originator or recipient.

Cost Drivers for VoIP

Per-minute cost recovery has a number of weaknesses in a VoIP world. Call duration has no meaningful relationship to the costs of a VoIP call. Charging on a per-minute basis creates opportunities for VoIP operators to engage in regulatory arbitrage, or to avoid interconnection charges.

As VoIP traffic increases, interconnection charges based on bandwidth used would better reflect underlying cost drivers, and would be more consistent with economic efficiency.

Setting Cost-Based Charges for VoIP Interconnection

An interconnection pricing mechanism for VoIP services should reflect the costs of the local network assets used to provide VoIP. If interconnection prices reflect underlying costs and appropriate cost drivers, opportunities for arbitrage will decline. Similarly, where VoIP operators provide a service that is functionally equivalent to conventional telephony, treating VoIP providers in the same way as conventional service providers will remove arbitrage opportunities.

Reciprocal Payment Obligations

VoIP operators currently do not receive any compensation from PSTN operators for terminating calls that originate on the PSTN. If VoIP operators are treated in the same way as other service providers with respect to interconnection payments, then they should also have the same rights to compensation. That is, VoIP providers should also be entitled to reciprocal compensation for terminating calls that originate on the PSTN.

Criteria for a New Interconnection Regime

As more traffic migrates to VoIP, a new approach to interconnection pricing is needed. Any new approach to interconnection pricing should:

- encourage efficient competition and the efficient use of, and investment in, telecommunications networks,
- preserve the financial viability of universal service mechanisms (thus any proposal that would result in significant reductions in intercarrier payments should include a proposal to address the shortfall),
- treat technologies and competitors neutrally,
- allow innovation, and,

- minimize regulatory intervention and enforcement, consistent with the general trend toward less regulation wherever possible.

This implies treating VoIP providers that provide service over the PSTN in the same way as other telecommunications service providers, with respect to the following:

- *Interconnection charges.* VoIP providers should face the same payment obligations as other service providers that use equivalent facilities and services. Similarly, VoIP providers should be entitled to the same reciprocal termination payments from PSTN operators.
- *Regulatory fees.* Technology neutrality suggests that all providers (including VoIP providers) whose service accesses the PSTN should be subject to the same regulatory fees, including universal service contributions.
- *Other regulatory requirements.* Where feasible, VoIP providers should have similar obligations to other service providers that offer a functionally equivalent service (for example with respect to emergency services, or obligations to support law enforcement call intercepts).

VoIP Over Wireless Networks

Wireless networks will have a substantial impact on VoIP service development, particularly in developing countries.

As wireless and VoIP traffic increase, differences in the terms and conditions under which wireline, wireless and VoIP operators interconnect networks will create opportunities for arbitrage, and distort markets. Differences in call termination rates and interconnection arrangements can cause operators to adjust traffic flows to obtain the lowest possible rate, and to minimize regulatory fees.

5.6.2. Enhancing Public Safety**Emergency Telephone Service**

Emergency telephone service is one of the most critical areas in which voice telephony remains the central and indispensable form of communication. Citizens facing emergencies – fire, health crises, accidents, crime, natural disasters – need to be able to contact public safety authorities in real time, to explain their needs to a live respondent, and to receive help as quickly as possible. Most governments have established mandatory public

emergency telephone numbers that can be called from any phone, and policies for how telecom operators must treat calls to those numbers, as well as how officials should respond. There are some significant differences, however, in how effectively some of these policies are implemented, and new challenges that arise in the context of the changing technical and market status of voice telephone service.

In most countries, one or more standard, nationwide short number codes, of two or three digits, must be automatically routed over all networks to public safety or emergency offices, or to trained dispatchers who can both assist callers and contact appropriate authorities. In the European Union, most countries utilize 112 as the primary emergency number, with a variety of alternative numbers for specific needs. In the Americas, 911 is the most common emergency number, while 999 is used in much of Africa and Asia. However, there is no strong standardization outside of Europe, with many unique numbers, and some of two or even four digits. These numbers can typically be called without charge from public pay telephones, private landlines, mobile phones, and usually even VoIP services, although there are some limitations and challenges regarding some of these options (see below).

Mobile Emergency Service Issues

A number of specific issues have arisen around the use of mobile phones to access emergency services. Mobile phones present a variety of unique challenges, as they can be taken anywhere, including across national borders where emergency service numbers may differ, and they also typically require active SIM cards to function properly. Most phones also have keyboard locking options, which can become a hindrance in an urgent situation or when a caller must use another person's phone to place an emergency call.

Under international agreements, most GSM service providers have addressed many of these issues, at least in part, and it is important for regulators to ensure compliance and cooperation as part of emergency telephone service regulations. For example, mobile phones and SIM cards are typically programmed with the full list of standard emergency codes, and dialing any of these will route a call to local emergency services, regardless of the official code for that country. This ensures, for example, that foreign visitors who may be accustomed to

different codes or have their home emergency numbers pre-programmed in their phones, will automatically reach assistance when calling those numbers. However, in countries where non-standard numbers may be used, especially two-digit codes, regulators should require operators to provide clear plans, including system tests, to assure that all phones and SIM cards will work properly with the system. The GSM network can also update the list of well-known emergency numbers when the phone registers to it.

Most GSM mobile phones can dial emergency calls even when the phone keyboard is locked, or an emergency number is entered instead of the phone's PIN. On some networks, a GSM phone can be used to make emergency calls even without a SIM card. However, some GSM networks, such as several in Latin America, will not accept emergency calls from phones without a SIM card, or even require a SIM card that has credit. In the United States, the FCC requires networks to route every mobile-phone and payphone 911 call to an emergency service call center, including phones that have never had service, or whose service has lapsed. Regulators should seek to harmonize access to emergency networks on GSM mobile phones, regardless of SIM card or credit status.

Identifying Caller Location

A vital component of the emergency service model is for responding authorities to be able to locate and reach the calling party as quickly as possible. To facilitate this goal, traditional emergency call services have been "enhanced" with location databases which can identify the physical address associated with a calling number, for example even if the calling party is cut off or unable to speak after the call is answered. These enhanced emergency services, however, were designed initially to work with traditional landlines, where addresses and phones were fixed. To obtain location identification for mobile phone users, and also for telephone calls placed via the Internet (VoIP calls), is significantly more difficult.

For mobile phones, the network is capable of identifying a caller's location to within a narrow radius, so the main challenge is ensuring that this information is coordinated with emergency networks in real time, whenever an emergency call is placed. For VoIP users, however, there is no inherent location data linked to network calls, and

only those subscribers who have obtained home or office based fixed VoIP service are likely to have an address associated with their telephone number. Many VoIP users, however, utilize the service from laptops or Internet cafés, or through VoIP-enabled smart phones and other devices, which provide no location signal, and could lead emergency response teams to lose vital time in reaching crises.

Technicians specializing in Internet architecture have begun to address this problem with VoIP. In January 2008, the Internet Engineering Task Force (IETF) issued a memo entitled “Requirements for emergency context resolution with Internet technologies”.¹¹ The memo provides a standardized set of terminology, concepts, and target objectives for IP-based emergency calls, with particular emphasis on establishing criteria for cooperative relationships among multiple actors to ensure that emergency callers can be identified by location. These include ISPs, Internet Access Providers (IAPs), Applications Service Providers (ASPs), as well as emergency service offices. The Task Force proposed an architecture that maps Internet callers to locations via an emergency service “routing proxy”, with a variety of specific protocols to be implemented. Regulators that authorize and oversee VoIP services should consider requiring formal adoption of these or similar measures, along with public notification of the potential risks in relying solely upon VoIP services, in case of emergency.

Finally, an even more basic challenge with respect to emergency telephone services and caller locations is the need to ensure that adequate public safety response capabilities are actually within reasonable distance of most areas, and that the calling system properly routes calls to the nearest response team once the location is identified. This can be a very big challenge in less developed and rural regions, where police, fire, ambulance, and other emergency resources are few and far between. In some cases, emergency calls may need to be routed initially to local government offices or other community locations where some type of authority is likely to be available, who can provide a first response while more distant resources are mobilized. Developing a comprehensive database and geographic routing system for emergency calls throughout the national territory should be a cooperative effort of regulators, public safety officials, local administrations, and telecommunications operators, and should be a priority effort wherever such systems are not adequately in place.

5.6.3. Other Challenges for Developing Countries

Establishing a regime to develop and implement interconnection rates, terms and conditions, and other provisions can place significant demands on a developing country’s legal and administrative infrastructure. This section considers particular challenges that may be significant for developing country regulators.

Many of these challenges apply to all countries, but are more difficult in countries with weak legal systems or no tradition of decision-making by independent regulators.

Key challenges include:

- The physical state of telecommunications networks in developing countries;
- Transparency and access to information;
- Regulating state-owned operators;
- Free trade negotiations; and
- Dispute resolution.

Infrastructure Challenges

Compared to developed countries, ICT infrastructure in developing countries has a number of features that create both challenges and opportunities:

- Developing countries may not have extensive telephone network coverage, particularly outside main population centers.
- Wireless and mobile operators often play a significant role, particularly in rural and remote areas. Typically, wireless demand in developing countries exceeds wireline demand, sometimes by significant amounts.
- Fiber-optic systems are often not widely rolled-out (or not all fiber is “lit” with the necessary electronics). Customers may have limited or no access to broadband services, particularly in rural areas.
- The technology in use, and network architecture, are often outdated.

These factors create a number of challenges. In particular, significant investment may be needed to achieve universal access goals or to make broadband service widely available.

At the same time, developing countries that are designing interconnection regimes now have the opportunity to design better regulatory regimes. The fact that traditional wireline technologies are not deeply embedded in many developing countries enables regulators to implement interconnection policies that are more appropriate to wireless networks, VoIP, and other emerging technologies. For example:

- The prominence of per-minute rates is a product of wireline technology. Per-minute rates may be irrelevant, or even counterproductive, when applied to VoIP services.
- Policies seeking to “unbundle” network elements assume that the wireline incumbent enjoys a near monopoly position in the provision of critical ICT infrastructure. This assumption may not be valid in many developing countries.

The absence of a well-established interconnection regime may allow regulators in developing countries to bypass policies that are no longer appropriate, in favor of arrangements that are sustainable, minimize opportunities for arbitrage, and are more in line with emerging technologies.

Internet Exchange Points

Regional IXPs play an important role in reducing the costs of ISPs and encourage development of the Internet in developing countries. Here we discuss:

- the role of regional IXPs;
- ways to support the development of IXPs in developing countries; and
- the development of IXPs in Africa

Because the Internet offers access to content and users anywhere, each ISP has to secure network connections to all potential senders and recipients of content, or suffer competitively for the lack of global reach. Reciprocal interconnection – whether freely provisioned or provided for a fee – makes it possible for an ISP to access the entire global Internet “cloud” for its subscribers.

The Internet operates almost free of regulation, so large ISPs can largely dictate interconnection terms and conditions. ISPs in remote areas (including most developing countries) must meet the entire cost of accessing larger ISP networks, using expensive international satellite links or submarine cables.

In some cases, where there is no local or regional facility for the exchange of Internet traffic, developing country ISPs must pay for international transit facilities to deliver local traffic. This practice is known as “tromboning.”

A key way to reduce Internet traffic costs for developing country ISPs is through the development of regional IXPs.

Supporting IXPs in Developing Countries

IXPs in developing countries are important for a number of reasons. They:

- enable efficient, cost effective management of Internet traffic,
- provide an interface between multiple ISPs, which enables them to avoid tromboning local and regional traffic, and,
- should help stimulate market entry by new ISPs, web hosting and equipment co-location developers, and content creators.

Internet Exchange Points in Africa

Until recently, Africa was especially disadvantaged by the absence of IXPs. Compared to other continents, Africa had limited connectivity options and low initial traffic volumes. As a result, African ISPs often faced high transmission costs, even when routing local and regional traffic, due to the need to “trombone” traffic. Tromboning increases delays and can reduce the quality of the transmission.

In addition, African ISPs pay a substantial premium for overseas connections. International connectivity charges can be between 15 and 26 times greater than their equivalent local costs. In response to these pressures, IXPs are now emerging in Africa. Some examples include:

- Angola Internet Exchange (ANG-IX)
- Mozambique Internet Exchange (MOZ-IX)
- Internet Exchange Point of Nigeria (IXPN)
- Johannesburg Internet Exchange (JINX)
- Tanzania Internet eXchange (TIX)

Transparency and Access to Information

In many developing countries, ensuring the transparency of interconnection arrangements and access to information are key challenges.

Transparency

Many countries require dominant operators to make the terms and conditions of interconnection transparent. In addition, the WTO requires Members to ensure that agreements or model interconnection offers of major suppliers are made public.

The objective of such transparency is generally to prevent dominant operators from discriminating between different competitors or otherwise acting to limit competition. Requiring operators to publish interconnection agreements enables regulators and other operators to monitor interconnection terms and agreements and to identify discriminatory or potentially anti-competitive behavior.

Transparency is also important in regulatory processes. For a regulator's decisions to be credible, the regulated firm and other stakeholders must have confidence in the decision-making process. Ways to achieve this include public consultation processes and requirements for regulators to publish the reasons for their decisions.

Regulatory transparency may be difficult to implement in countries with weak legal and administrative structures and that have no tradition of transparency. However, where an independent regulator has been recently established, there is an opportunity to introduce procedures for regulatory transparency.

Access to Information

In order to regulate effectively, a regulator needs access to detailed information about the regulated firm. For example, regulators often require detailed cost information and information on the regulated firm's cost of capital.

In many developing countries such detailed information is simply not available. The incumbent firm may not have sufficiently detailed network data to enable long run incremental cost modeling. Or the regulator may not have sufficient powers to require the regulated firm to provide the information.

Where this is the case alternative, less data-intensive approaches can be taken. These approaches include:

- Top down cost models: these models are based on the firm's existing financial accounts. The ITU's COSITU model is a top down cost model that has been designed for use in developing countries (see Box 5.4).

- International benchmarking: benchmarking can be used to estimate interconnection prices or individual inputs for costing exercises. (For example, COSITU provides benchmark data for the inputs needed to estimate cost of capital, where this information is not available).

Box 5.4 COSITU: Calculation of Costs, Tariffs and Rates for Telephone Services

The COSITU model permits network operators, service providers, regulators, and policy makers to calculate costs, taxes related to trade in international traffic, interconnection rates between local and international operators, and tariffs for national and international telephone services, both for fixed and mobile.

COSITU is based on enhanced fully distributed costing principles, as adopted in the ITU-T D series of recommendations. These can be viewed here (under "Recommendations", click on "D-series").

Various categories of fixed and mobile operators can use COSITU:

- Vertical operators managing international and national traffic with complete geographical coverage,
- National operators with urban and interurban area coverage,
- National operators with urban area coverage only.

In addition, regulators and public authorities in developing countries can use COSITU as a policy-making tool, to calculate costs, tariffs, and rates for telephone services.

COSITU can calculate cost-oriented tariffs for the following categories of telecommunication services:

- Urban,
- Interurban,
- International,
- Subregional, and
- Interconnection.

The model also allows users to:

- Simulate the effect on service tariffs of universal service or tariff rebalancing policies, and
- Calculate inefficiency costs, and
- Benchmark computed data.

Source: ITU, <http://www.itu.int/ITU-D/finance/COSITU/index.html>

5.7. Dispute Resolution

Disputes pertaining to access, interconnection, and other aspects of regulation are common in the ICT sector. This can stall the development of competition and the implementation of important

national policy goals for infrastructure and economic development.

Reliance on the courts to resolve disputes between telecommunications firms is costly and can involve substantial delays. For example, in New Zealand the first major interconnection dispute between the incumbent and a new entrant took over three years to resolve through the courts and even then failed to deliver a conclusive resolution.

Without a mechanism to resolve interconnection disputes quickly and effectively, innovation and competition in the sector will be threatened. Entrants will not commit resources unless they have confidence that their business will be viable and that they will be able to resolve any disputes in a timely fashion.

The Role of the Regulator

The World Trade Organization Agreement on Basic Telecommunications includes obligations relating to dispute resolution. Under the Agreement, Member countries must establish an independent domestic dispute resolution body, so that interconnection disputes can be settled within a reasonable period of time. This need not be the regulator, but it often is.

Often a regulator will require the development of a Reference Interconnection Offer (RIO) as part of opening the sector to competition. The RIO sets forth the terms and conditions for interconnection services, and prices, that a competing operator can choose to accept without further negotiations. The purpose is to avoid disputes and to shorten the entry time for a new competitor. The requirement to develop a RIO is most usually imposed on an operator that is deemed to be dominant or have significant market power (often the incumbent operator). A regulatory tool that accomplishes similar things is a “most favored nation” or nondiscrimination requirement, whereby any operator can choose to accept the terms and conditions that have previously been agreed or ordered to be in place for another competitor. Many countries have adopted either or both of these measures.

Challenges for the Regulator

Dispute resolution presents a number of challenges for regulators, including:

- Access to information: Operators usually have better information than the regulator on the

details of interconnection disputes. This makes it difficult for the regulator to come to a decision and be confident that it is the best one.

- “Gaming” of the process: Either party may engage in anti-competitive gaming of the dispute resolution process. For example, an incumbent may use delaying tactics to draw out the proceedings, in order to delay competitive entry. Or an entrant may not accept a reasonable interconnection offer from the incumbent if it believes that it can persuade the regulator (or dispute resolution authority) to mandate more favorable terms.
- Capacity: Many countries face a shortage of people with the necessary legal, economic, and technical expertise to resolve interconnection disputes.

Ways to Strengthen Dispute Resolution Processes

Options to strengthen dispute resolution processes include:

Improve information available to the regulator

To enable the regulator to base its decision on better information:

- Ask parties to define areas of agreement and dispute and to provide information to clarify disputed issues;
- Require written submissions from operators on areas of dispute, supported by facts and research if necessary; and
- Allow others (for example customer groups and other service providers) to comment on areas of dispute.

Obtain Expert Assistance

To supplement the regulator’s in-house capability by drawing on external expertise:

- Use external advisors (for example an experienced interconnection expert) to assist in resolving the dispute. The expert’s role could include clarifying areas of agreement and dispute, identifying information needs, and providing advice.
- Consider appointing an independent mediator (or, if the parties agree, an arbitrator).

- Consult with other regulators on their approach in similar cases.
- Review decisions and interconnection agreements approved by other regulators.
- Use outside parties for informal mediation, arbitration, information gathering or other assistance. This can be particularly useful in countries where the regulator lacks the legal authority to resolve the dispute, or may be biased.

Improve Transparency

Making more information publicly available should cause parties to consider their positions more carefully:

- Make parties' submissions available for comment by other parties and the public, with summaries to protect confidential information; and
- Publish a draft decision and give parties to the dispute and others an opportunity to make written submissions on it