

Telecommunications Regulation Handbook

Appendices

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Telecommunications Regulation Handbook

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Telecommunications Regulation Handbook

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APPENDIX A – WTO REGULATION REFERENCE PAPER

Annex to the Fourth Protocol to the GATS Agreement, the “Agreement on Basic Telecommunications” negotiated under the auspices of the World Trade Organization (WTO) in February 1997, which came into effect on 1 January 1998.

This Reference Paper forms part of the commitments of most of the original 69 signatories to the Agreement on Basic Telecommunications. Several signatories committed to somewhat different wording. Others have subsequently committed to implement the regulatory framework set out in the Reference Paper.

REFERENCE PAPER

Scope

The following are definitions and principles on the regulatory framework for the basic telecommunications services.

Definitions

Users mean service consumers and service suppliers.

Essential facilities mean facilities of a public telecommunications transport network or service that:

- (a) are exclusively or predominantly provided by a single or limited number of suppliers; and
- (b) cannot feasibly be economically or technically substituted in order to provide a service.

A major supplier is a supplier which has the ability to materially affect the terms of participation (having regard to price and supply) in the relevant market for basic telecommunications services as a result of:

- (a) control over essential facilities; or
- (b) user of its position in the market.

1. Competitive safeguards

1.1 Prevention of anti-competitive practices in telecommunications

Appropriate measures shall be maintained for the purpose of preventing suppliers who, alone or together, are a major supplier from engaging in or continuing anti-competitive practices.

1.2 Safeguards

The anti-competitive practices referred to above shall include in particular:

- (a) engaging in anti-competitive cross-subsidization;

- (b) using information obtained from competitors with anti-competitive results; and
- (c) not making available to other services suppliers on a timely basis technical information about essential facilities and commercially relevant information which are necessary for them to provide services.

2 Interconnection

2.1 This section applies to 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.

2.2 Interconnection to Be Ensured

Interconnection with a major supplier will be ensured at any technically feasible point in the network. Such interconnection is provided.

- (a) under non-discriminatory terms, conditions (including technical standards and specifications) and rates and of a quality no less favourable than that provided for its own like services or for like services of non-affiliated service suppliers or for its subsidiaries or other affiliates;
- (b) in a timely fashion on terms, conditions (including technical standards and specifications) and cost-oriented rates that are transparent, reasonable, having regard to economic feasibility, and sufficiently unbundled so that the supplier need not pay for network components or facilities that it does not require for the service to be provided; and
- (c) 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 necessary additional facilities.

2.3 Public Availability of the Procedures for Interconnection Negotiations

The procedures applicable for interconnection to a major supplier will be made publicly available.

2.4 Transparency of Interconnection Arrangements

It is ensured that a major supplier will make publicly available either its interconnection agreements or a reference interconnection offer.

2.5 Interconnection: Dispute Settlement

A service supplier requesting interconnection with a major supplier will have recourse, either:

- (a) at any time or
- (b) after a reasonable period of time which has been made publicly known to an independent domestic body, which may be a regulatory body as referred to in paragraph 5 below, to resolve disputes regarding appropriate terms, conditions and

rates for Interconnection within a reasonable period of time, to the extent that these have not been established previously.

3 Universal Service

Any Member has the right to define the kind of universal service obligation it wishes to maintain. Such obligations will not be regarded as anti-competitive per se, provided they are administered in a transparent, non-discriminatory and competitively neutral manner and are not more burdensome than necessary for the kind of universal service defined by the Member.

4 Public Availability of Licensing Criteria

Where a licence is required, the following will be made publicly available:

- (a) all the licensing criteria and the period of time normally required to reach a decision concerning an application for a licence; and
- (b) the terms and conditions of individual licences.

The reasons for the denial of a licence will be made known to the applicant upon request.

5 Independent Regulators

The regulatory body is separate from, and not accountable to, any supplier of basic telecommunications services. The decisions of and the procedures used by regulators shall be impartial with respect to all market participants.

6 Allocation and Use of Scarce Resources

Any procedures for the allocation and use of scarce resources, including frequencies, numbers and rights of way, will be carried out in an objective, timely, transparent and non-discriminatory manner. The current state of allocated frequency bands will be made publicly available, but detailed identification of frequencies allocated for specific government uses is not required.

APPENDIX B – THE ECONOMICS OF TELECOMMUNICATIONS PRICES AND COST

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APPENDIX B – THE ECONOMICS OF TELECOMMUNICATIONS PRICES AND COSTS

This Appendix provides an overview of the economic theory and practice of price regulation (tariff setting) and costing in telecommunications. It contains background information relevant to several of the modules in this Handbook. It is particularly relevant to Module 4, which focuses on price regulation.

The concepts addressed in this Appendix are also relevant to other Modules. In particular, telecommunications costing and pricing concepts underlie many of the issues related to Interconnection (Module 3), Competition Policy (Module 5), and Universal Service (Module 6). Having said that, the world of economic theory and practice is not for everyone. We have concentrated a discussion of these concepts in this Appendix to be read by those with a particular interest in the subject.

We start this Appendix with a discussion of the benefits of competition and the alternatives available when markets fail to produce socially-optimal results. We then review the theoretical and practical applications of monopoly pricing, including Ramsey pricing. We provide a survey of telecommunications elasticity estimates. The last half of this Appendix is devoted to a survey of telecommunications costs, including different costing perspectives, terms and definitions. We discuss some of the costing methodologies adopted by regulators around the world, including the FCC's TELRIC and the European Commission's LRAIC. We conclude with a specific interconnection costing example.

This Appendix covers a range of topics, from general economic theory to very specific economic applications of the theory in the telecommunications sector. We have only provided a summary treatment of the principal topics, and we have simplified the discussion of certain issues. Readers interested in a more detailed and technically specific treatment are directed to the selected sources listed in Appendix D.

1.1 *The Economic Rationale for Price Regulation*

In the following Section, we review the economic theory relating to the benefits of competition. We also review the cost characteristics of telecommunications networks that constrain competition and that provide a rationale for continued price regulation of dominant operators in the telecommunications sector.

1.1.1 *Benefits of Competition*

According to economic theory, price regulation is justified when markets fail to produce competitive prices. If markets are competitive and function smoothly, theory predicts that they will lead to “efficient” prices that maximize society’s welfare. Specifically, efficient prices will equate the amount of a service that sellers want to supply to the amount of a service that buyers demand. Efficient prices will equal the benefit that buyers get from the last unit consumed and the cost of producing the last unit supplied (the marginal cost).

The general economic theory of efficient competitive markets is illustrated below. Figure B-1 shows the market demand curve, *D*, for a particular service. The demand curve is plotted on a graph with the price of the service (the “own-price”), *P*, on the vertical axis (the “y-axis”) and the quantity of the service, *Q*, on the horizontal axis (the “x-axis”). Because consumers will want more of the service when the price is lower, the demand curve is drawn sloping downwards from left to right, to show that market demand increases as price decreases, and vice-versa. Total market demand is determined by adding together the demand curves of individual consumers.

Figure B-2 shows the market supply curve, *S*, for the service. This curve slopes upward to the right, showing that more services will be provided by firms as the price of the service increases. In this example of a perfectly competitive firm, we assume constant or decreasing returns to scale (see discussion of these and other cost concepts below). Under this assumption, the supply curve of a perfectly

Figure B-1: Market Demand Curve

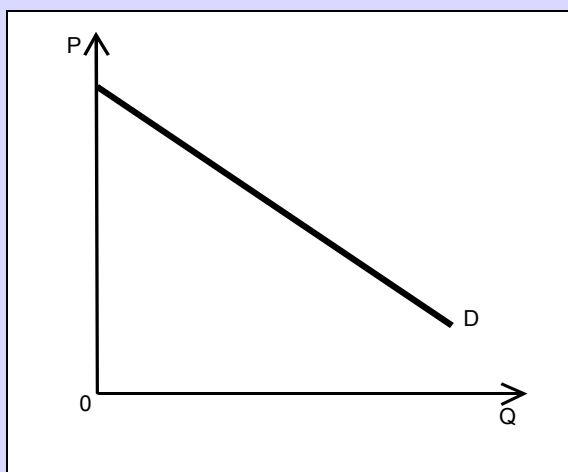
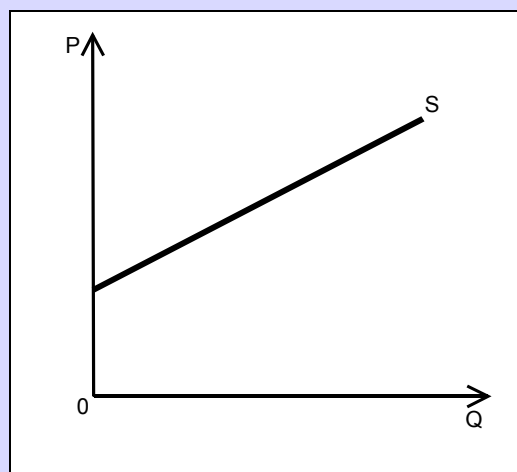


Figure B-2: Market Supply Curve



competitive firm is that portion of the marginal cost (MC) that lies above the average variable cost curve. Total market supply is determined by adding together the supply curves of individual firms.

Figure B-3 shows the market equilibrium when firms (suppliers) and consumers interact. At market equilibrium, the demand and supply curves intersect at the market price P^* and market output Q^* . In summary, competitive markets will lead to an efficient price P^* , at which the amount suppliers want to provide, Q^* , equals the amount buyers demand. Given that for each firm the supply curve is the marginal cost curve, at market equilibrium the firm will produce up to the point where the price is equal to marginal cost – that is, the level of output at which P^* equals marginal cost.

Figure B-4 shows that social welfare is maximized at the competitive equilibrium (price P^* , output Q^*). Assuming that the area under the demand curve represents consumers' total willingness-to-pay and the area under the supply curve represents suppliers' total cost, the difference between these two concepts is area ABC. This is often referred to as "social surplus" or "total surplus".

Total surplus may be divided into consumer surplus of AP^*B (the difference between total willingness to pay $0Q^*BA$ less what consumers must actually pay $0Q^*BP^*$), and producer surplus of P^*CB (the total difference (profit) between the revenues $0Q^*BP^*$ and the costs incurred $0Q^*BC$). It can be shown that no other combination of prices will result in as much total surplus. In short, equating price and marginal cost at output Q^* maximizes total surplus and, hence, social welfare. This is why economists refer to marginal-cost pricing as "efficient".

This, then, is the situation in this ideal competitive marketplace. For this efficient ideal to be realized, the market must meet a number of conditions. For instance, the market must have several sellers (suppliers) and buyers (consumers), with none so large that it can affect prices: no one can be dominant in the marketplace. In addition, there must be no significant externalities, loosely defined as spillover benefits or negative effects to/from other markets. There should also be free entry to and exit from the market. Finally, as mentioned above, this market should not be characterised by economies of scale.

Figure B-3: Market Supply and Demand

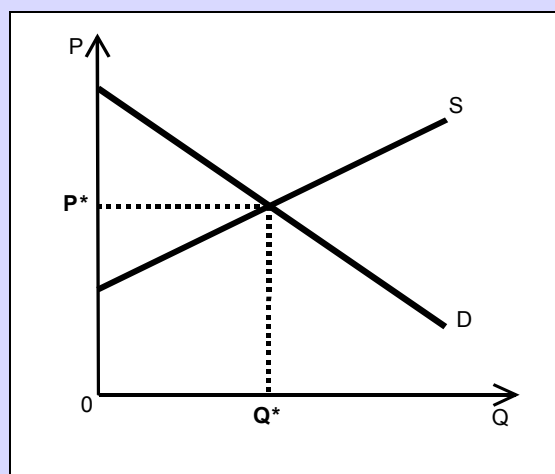
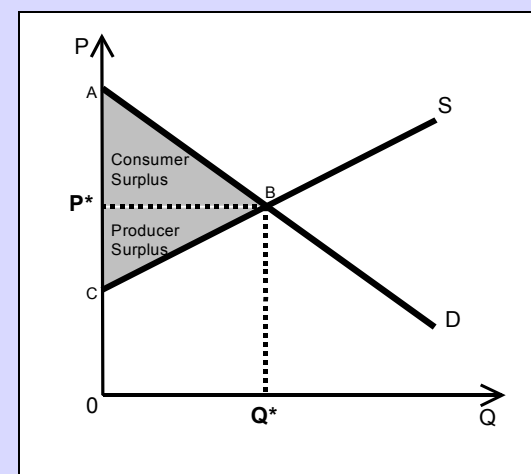


Figure B-4: Social Welfare of Marginal Cost Pricing



This conventional description of competitive markets generally will not be applicable to the telecommunications sector because of the specific cost characteristics of telecommunications networks. We discuss these cost issues in the sections below.

1.1.2 When Markets Fail

Where all the conditions mentioned above are not present, the market will not generally produce socially-optimal results. Economists call this “market failure”. Market failure occurs when resources are misallocated, or allocated inefficiently. The result is waste or lost value. In such a situation, there is justification for government intervention to improve social welfare. Clearly, the impetus for regulation must be weighed against its economic and bureaucratic costs, in order to avoid or minimize “regulatory failure”. Module 1 of this Handbook provides guidelines for effective and efficient regulation in the telecommunication sector.

In traditional economic theory, natural monopoly is cited as a prime example of market failure. Loosely defined, a natural monopoly exists when the costs of

production are such that it is less expensive for market demand to be supplied by one operator than by several. A natural monopoly arises from two sources: economies of scale and economies of scope. Economists use the concept of “subadditivity” to describe and test for natural monopoly.

1.1.2.1 Economies of Scale

Economies of scale exist when the average (total) cost of the firm decreases with the volume of production. Figure B-5 illustrates how a supplier's long-run average cost (AC) declines as a result of economies of scale. Economies of scale are also referred to as increasing returns to scale. Conversely, diseconomies of scale, or decreasing returns to scale, exist when average costs increase with the volume of production. Constant returns to scale exist when average costs are constant with the volume of output.

Economies of scale can arise from a number of technological and managerial factors. One common source of economies of scale, especially in the telecommunications sector, is fixed costs (i.e. costs that

are incurred regardless of how many units of output are produced). Fixed costs are significant in telecommunications and in other industries that require networks. When output expands, average fixed costs will decline. This phenomenon will exert a downward pressure on average cost that may result in economies of scale. Note that the existence of fixed costs does not necessarily mean that the firm will have economies of scale. As noted above, economies of scale can be due to factors other than fixed costs.

Economies of scale can exist over some ranges of outputs, but not others. For instance, at high levels of output, management might not be able to oversee closely all the operations of the firm, giving rise to inefficiencies that can dominate any technological cost advantages of large-scale operation.

The existence of economies of scale depends on whether average (total) cost increases or decreases in the long run. Average total cost is made up of two components: average fixed cost and average variable cost. As discussed above, average fixed cost decreases with output. However, average variable cost may increase more or less rapidly than output. Economies of scale depends on the

combined behaviour of these two components as output increases.

For a single service firm, a natural monopoly exists if economies of scale arise over the relevant range of output relative to actual and future demand. When the firm produces more than one service, average costs are not clearly defined. In this instance, economists have developed a number of criteria to represent and test for economies of scale. The general idea remains the same as in the single service example: a multi-service firm with economies of scale can increase all of its services in proportion with a less than proportional increase in its total costs.

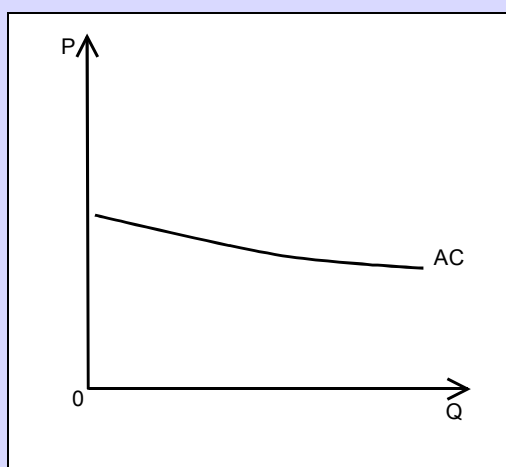
1.1.2.2 Economies of Scope

When more than one good is being produced, a natural monopoly can arise from economies of scope as well as from economies of scale. With several goods, there are sometimes shared equipment or common facilities that make producing them together less expensive than producing them separately. Economies of scope exist if a given quantity of each of two or more goods can be produced by one operator at a lower total cost than if each good were produced separately by different operators.

Economies of scope refers to the cost advantage of one operator supplying two or more products or services compared to different operators each providing one. A local PSTN operator, for example, already has a network for local subscribers. With appropriate interconnection to long distance facilities, the local network can also be used to provide long-distance service to customers. Using the local network for long distance service will provide the local operator with economies of scope that would be unavailable to a new operator that aimed to provide just long-distance services. The latter would have to replicate the local network to access subscribers.

A somewhat similar curve to that in Figure B-5 would represent the effect of economies of scope on aggregate average costs of an operator providing several products or services, recognizing that different curves would appear for each individual output.

Figure B-5: Average Cost under Economies of Scale



As with economies of scale, it is possible for economies of scope to exist at some levels of output and not at others. Economies of scope can exist with or without economies of scale.

1.1.3 The Monopoly Problem

The traditional view was that the entire telecommunications sector had natural monopoly characteristics. This implied that key telecommunications markets would fail to meet the competitive condition that there be many sellers in the market. In effect, the traditional industry structure was that of monopoly.

The problem is that the monopolist may exploit its position by charging excessive prices or restricting output. This leads to losses of social welfare (market failure) and sets the scene for government intervention to ensure that consumers and potential competitors are not exploited by the power of the monopolist.

1.1.4 Regulated Monopoly

Governments have addressed the monopoly problem in a number of ways. The main one is regulation. Government policy makers that believed the telecommunications industry to be a natural monopoly decided that citizens would best be served by a single monopolist that can exploit economies of scale and scope. However, traditional telecommunications policies imposed regulations to prevent the monopolists from exercising monopoly power and charging excessive prices. This compromise was aimed at capturing the benefits of productive efficiency without permitting an unrestrained monopolist to earn excessive profits or restrict supply of its services.

In some cases, this view that monopoly was the socially optimal market structure provided a rationale for creating regulatory or legislative barriers to entry in monopoly markets. This transforms a natural monopoly into a legal monopoly. In practice, the regulated monopoly model was implemented through privately owned operators in a number of countries, including the US and Canada.

1.1.5 Public Enterprise

The most common alternative model to regulated private monopoly is public ownership of the operator in a monopoly environment. This model is based on the belief that sector objectives are more likely to be achieved through direct public control and ownership of the enterprise actually providing the services. In such a model, therefore, regulation is often thought to be unnecessary. Until recently, monopoly public ownership was the prevalent sector model in many countries in Europe, Africa, Asia, Latin America and the Caribbean.

In practice, however, public enterprises are used for a variety of tasks of which handling the natural monopoly problem is just one. Given these conflicting tasks and historically poor performance, many governments have abandoned or are abandoning the unregulated public enterprise model. In some jurisdictions, there was a recognition that the rationale for economic regulation was strong whether the operating firm was private or public. State-owned operators were sometimes established as separate “commercialized” or “corporatized” entities, subject to regulation by a different government body.

1.2 Monopoly Pricing

1.2.1 Single Product Monopoly

There is a substantial body of economic theory and practice on the regulation of prices charged by a monopoly. A sample of this literature is included in the Selected Sources to this Appendix.

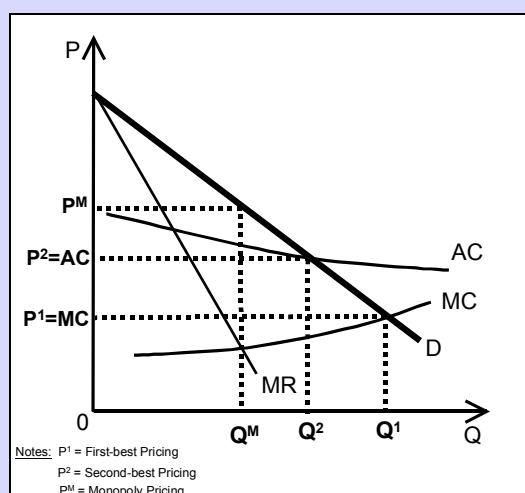
As seen in the foregoing discussion of the social welfare in an ideal competitive marketplace, economic theory states that “first-best” pricing sets prices equal to marginal cost. For a firm with economies of scale, such as a natural monopoly, however, this efficient pricing prescription is problematic. For such a firm, marginal cost is generally below average costs in the relevant range of output. This situation is illustrated in Figure B-6, where the demand curve and the marginal cost curve intersect below the average cost curve. In this instance, setting a regulated price equal to marginal cost, P^1 , will not allow the firm to recoup all of its costs. In such a case, the firm will lose money and

go out of business. Accordingly, regulators must find viable solutions to avoid this result.

In practical terms, this means that price will have to be set above marginal cost. But at what level? To maximize social welfare, departures from marginal costs should be set to minimize total surplus losses while allowing the supplier to break even. This is referred to as the second-best price; in the case of a single-product monopoly, it is the average cost. This price, P^2 , is set at the intersection of the average cost curve and the demand curve in Figure B-6.

Notice that the quantity associated with second-best pricing, Q^2 , is less than that related to first-best pricing, Q^1 . This reduction in quantity is an indication of the welfare losses due to economies of scale. These welfare losses, however, are small compared to those that would result if the monopolist were not price regulated. An unregulated monopolist would equate its marginal cost with its marginal revenue (MR curve in Figure B-6 and set a monopoly price, P^M , higher than its average cost. This pricing would result in monopoly profits for the firm, a reduction in the quantity supplied, Q^M , and additional welfare losses.

Figure B-6: Firm Loses Money at "First Best" Pricing under Economies of Scale



Note that unlike the perfectly competitive firm that has a well-defined supply curve (the marginal cost curve that lies above the average variable cost curve), the natural monopolist has no supply curve that is independent of the demand curve. The amount that an unregulated monopoly produces depends on its marginal cost curve and on the shape of the demand curve.

1.2.2 Ramsey Pricing

Telecommunications operators produce more than one service. The problem that first-best pricing is not commercially viable also applies to a multi-service telecommunications monopoly. Marginal cost pricing will not cover all the monopoly operator's costs, so prices must be raised until the operator can break even. With more than one service, however, there are an infinite number of price combinations that will produce this result.

Economic theory provides a recommendation as to how to deal with this issue. Out of all these price combinations, the second-best prices (i.e. the ones that result in the smallest loss of social welfare compared to marginal-cost pricing) are those that equate the amount by which price exceeds marginal cost in inverse relation to the elasticity of demand for each service. In other words, prices are raised above marginal costs more for services with a lower elasticity of demand and less for services with higher elasticity.

These second-best prices are often referred to as Ramsey prices named after the British researcher who originally studied the issue. This is also referred to as the "inverse elasticity rule." Ramsey prices minimize the changes in quantity purchased compared to the quantities that would be bought at prices equal to marginal cost. The general principle is that the products with the least price-sensitive demand should have the highest prices relative to their marginal costs.

Figure B-7 shows a simplified example of the application of Ramsey pricing principles when the operator provides two services. Ramsey principles are general enough to account for differences in cost; however, for simplicity, our example shows that the two services have the same marginal cost (MC) and that these costs are constant. Under this

assumption, both services have the same “first best” prices, P_1 , set at their marginal cost. In order to raise additional revenue, for instance, to cover all of its costs or to pay for regulatory levies (such as universal service, etc.) prices have to be raised above marginal cost. The application of Ramsey principles would mean that the price of the service with the relatively inelastic price demand would be raised proportionately more than the price of the service with relatively elastic demand. The resultant second-best Ramsey prices, P_2 , are higher for the relatively inelastic than for the elastic service.

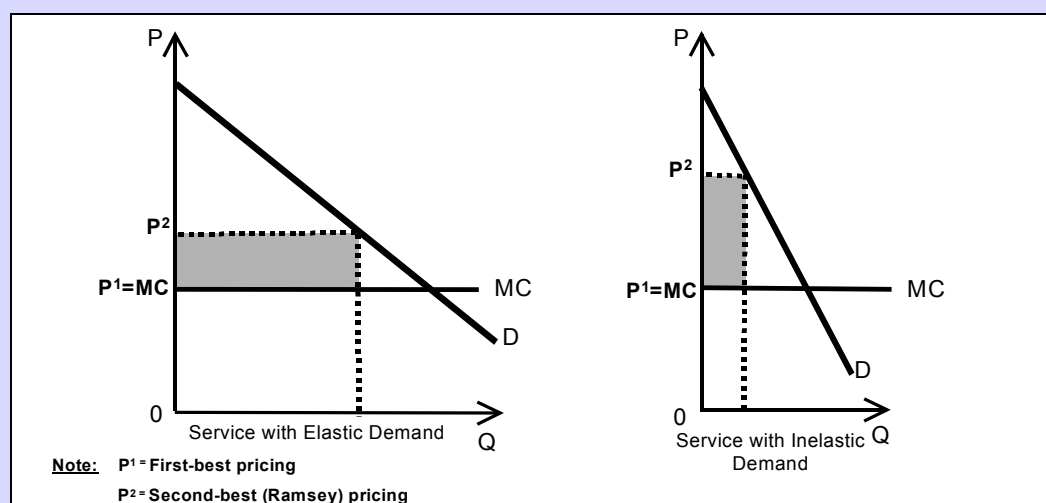
To apply Ramsey prices in an exact manner, regulators face two challenges. One is to determine the elasticity of demand for various telecommunications services. The other is to identify, as accurately as possible, the costs of providing these services. While the perfect application of Ramsey principles requires a great deal of information and hence presents implementation challenges, this does not mean that the basic Ramsey lesson (that relative demand elasticities of telecommunications services affect social welfare) should be ignored. Reasonable measures that approximate Ramsey principles will result in welfare improvements relative to alternate measures. A numerical example of these welfare

improvements is presented in the Appendix to Module 4.

The informational requirements to implement Ramsey pricing are less onerous for operators, who may be presumed to have a much better sense of the elasticities and costs involved than the regulator (another example of the “asymmetry of information” regulatory problem). Fortunately, recent research suggests that under certain conditions price caps regulation provides the operator with the correct incentives for it to set prices in a manner consistent with Ramsey prices. That is, an operator subject to price caps will tend to set economically efficient prices as a result of trying to maximize its profit – an example of incentive-compatible regulation.

Ramsey prices may also be referred to as Ramsey mark-ups. As explained in more detail in the next Section, a mark-up is a percentage or a fixed monetary amount that is used to take into account joint and common costs, to supplement certain incremental costing methodologies. Mark-ups may be uniform or non-uniform. While regulators have generally set uniform mark-ups to promote competition, the application of Ramsey principles suggests that a non-uniform mark-up may be more economically efficient.

Figure B-7: Example of Application of Ramsey Prices



1.2.3 Regulation under Increasing Competition

Policy-makers and regulators are quickly eliminating legal monopolies around the world. However, the end of legal monopoly does not mean the end of monopoly power or of natural monopoly. Hence, the end of legal monopoly does not mean the end of price regulation.

Economists now generally agree that many segments of the telecommunications sector are not characterised by natural monopoly. Infrastructure-based competition between multiple operators in long distance and mobile cellular service, for instance, has proven to be durable and sustainable. There is no economic consensus, however, on whether the access network remains a natural monopoly and, if so, to what extent.

The existence or not of natural monopoly characteristics in the access network may not matter

much. Given the historically poor performance of most legal monopolies, especially in developing countries, most policy-makers do not believe that the theoretical benefits of natural monopoly can be realized in a legal monopoly environment. Hence, there is a growing consensus that there is a favourable trade-off for the sector as a whole from the introduction of competition. There may be some loss of economies of scale, for instance, but these losses are more than offset by the gains in improved efficiency and responsiveness due to competition.

After the introduction of competition, many former monopoly (incumbent) operators will retain residual monopoly power (or “market power”) for extended periods of time. This will especially be the case in certain market segments, for instance the access network. Market power exists when incumbent operators are still able to unilaterally (or in combination with other operators) influence market conditions, especially prices. Firms with market power are therefore generally price regulated in

Box B-1: Price and Income Elasticities of Demand

The effects of many demand factors are typically measured by elasticities:

- **Price elasticities** measure the percentage by which the quantity demanded for a telecommunication service changes in response to a small percentage change in price.
 - For example, if a 1% decrease in the price of national long distance service leads to a 0.5% increase in national long distance calling, the price elasticity is -0.50 .
 - Elasticities with a value between 0.0 and -1.0 reflect inelastic demand.
 - Elasticities with a value smaller than -1.0 reflect elastic demand.
 - Elasticities with a value of -1.0 are said to be of unitary elasticity.
- One of the critical characteristics of elastic demand is that a reduction of prices will result in sufficient increased demand – stimulation – that revenues will in fact increase after the price decrease. On the other hand, revenues will decrease after a decrease in the price of an inelastic service.
- The elasticity of demand may be deduced from the slope of the demand curve. Generally, the steeper the demand curve, the more inelastic the demand. At one extreme, a vertical demand curve shows zero elasticity. In this instance of totally inelastic demand, the quantity demanded does not vary by price at all. For example, research suggests that business demand for telecommunications access can be almost totally inelastic.
- **Income elasticities** measure the percentage by which the quantity demanded for a telecommunication service changes in response to a small percentage change in income.

order to constrain their ability to charge excessive prices. The subject of market power and its impact on pricing is discussed further in Module 5 - Competition Policy.

1.3 Elasticity of Demand

In this section, we discuss the responsiveness of demand for telecommunications services to changes in prices. This is referred to as the (own-price) elasticity of demand and is of critical importance in a number of applications, including in the determination of Ramsey prices and the calculation of the welfare benefits of rate rebalancing. Box B-1 provides an overview of demand elasticities.

As for most other products, the demand for telecommunications services depends on factors such as consumers' demographic characteristics, their incomes, the prices of the services, and the availability and price of other communications options.

In considering price elasticities, it should be noted that telecommunications demand generally has two interrelated parts — access and usage. Local, long distance and international calls depend on having access, and access is of value only if using the network (calling) has value. Whereas most economic goods are substitutes, access and usage are complements. That is, if the price of access increases, the demand for access and usage both decrease. If the price of usage increases, demand for calls and access decreases.

1.3.1 Survey of Elasticity Estimates

Most studies of telecommunications demand have concentrated on voice telephony services. They are divided into studies of residential and business demand for access, local, long distance and international calls.

Estimates of elasticities are usually based on historical consumption patterns and are calculated using complex statistical techniques. As a result, determining the magnitude of elasticities is an empirical matter. Most of the elasticity studies to date have been done in industrialized countries. A significant and consistent body of literature now exists to provide point and/or interval estimates of

most price and income elasticities for important classes of telecommunications services.

Table B-1 summarizes the subjective estimates from the classic 1980 study conducted by Lester Taylor. (The results from this study are used as benchmarks by many consulting economists in industrialized and developing countries.) A second edition of the Taylor study was published in 1994.

The elasticity studies show that there is a range of price elasticities among telecommunications services. Access service is very price inelastic. Demand for access is more inelastic at higher rates of penetration. Domestic long distance and international calls are the most elastic services.. Demand for calling is more elastic the longer the distance of the call. Demand for any given service is less elastic for business users than for residential users.

Box B-2: Application of Industrialized Country Elasticity Estimates to Less Developed Markets

Care must be taken in interpreting elasticity estimates for industrialized telecommunications markets in developing countries. One of the principal reasons for low penetration rates in such countries is not lack of demand, but rather under-supply, shown by the long and ever-present waiting lists.

A change in price in capacity-constrained telecommunications markets is not likely to affect demand as much as is suggested by the elasticity estimates presented in this section (which were calculated in environments where supply is not constrained). It could be, therefore, that consumers in many developing countries are not on the same demand curve as their counterparts in mature telecommunications markets.

Recent research has confirmed this hypothesis. For instance, in studying the recent rate rebalancing initiatives in many Latin American countries, Ros and Banerjee (2000) found that an increase in monthly subscription prices actually lead to increases in penetration rates — that is, the quantity demanded.

Table B-1: Point and Interval Estimates of Price and Income Elasticities of Demand for Selected Telephone Services

Type of Demand	Price Elasticity			Income Elasticity
	Connection	Subscription	Long Distance	
Access	-0.03 (± 0.03)	-0.10 (± 0.09)		0.50 (± 0.10)
Local Calls		-0.20 (± 0.05)		1.00 (± 0.40)
Domestic LD Calls				
Shorter distance			-0.375 (± 0.125)	1.15 (± 0.25)
Medium distance			-0.65 (± 0.15)	1.25 (± 0.25)
Longer distance			-0.75 (± 0.20)	1.50 (± 0.40)
International Calls			-0.90 (± 0.30)	1.70 (± 0.40)

Notes:

In each cell, the first figure indicates the point estimate of the elasticity – that is the one best estimate of the variable. The second figure, preceded by $\pm$, indicates the subjective interval estimate for the elasticity – that is, the possible range of the variable. For example, medium distance domestic LD calling the price elasticity is estimated at about -0.65 with a possible range of -0.50 to -0.80 .

LD refers to long distance

Source: Adopted from Taylor (1980) and supplemented by Taylor (1994) and other elasticity studies.

1.4 Telecommunications Costs

Determining or verifying the costs for telecommunications services are among the most difficult challenges facing regulators. Nevertheless, cost analysis can be of crucial importance. In particular, regulators use cost analysis in setting or approving prices, including “retail” prices for consumers and “wholesale” prices for competitors (e.g. interconnection and unbundled network elements, etc.), and in enforcing competition policy.

The practice of determining costs in the telecommunications industry is often complex and controversial. Different cost approaches, concepts, definitions, interpretations and data sources lead to this complexity. Generally, the nature of the problem being addressed and the purpose of the costing exercise will determine which is the most appropriate approach to use.

1.4.1 Costing Perspectives

Most telecommunications cost analyses use one or more of the main perspectives outlined in Box B-3. Each is associated with the perspectives of a particular profession.

1.4.2 Costing Terms and Concepts

Box B-4 provides descriptions and some examples of the principal terms and concepts used in telecommunications cost analysis. These are the basic building blocks of cost analysis.

1.4.3 Costing Methods

In this section, we briefly review and compare some of the main costing methods used by telecommunications regulators over the years.

Most costing methods are based on the principle of cost “causality” (also referred to as cost causation). Simply stated, cost causality means that costs

Box B-3: Three Principal Costing Perspectives**Accounting Costs**

- This perspective focuses on the recording of the actual incurred costs by the operator. The focus is on the historically recorded costs (i.e. it is backward-looking). Data sources include corporate financial accounting and more detailed management accounting measures. In the past, regulators relied almost exclusively on accounting data as their source of information for cost studies.

Engineering Costs

- This perspective is primarily concerned with forward-looking management decisions. Engineering cost analyses assess different ways of meeting a specified objective, such as provisioning a certain amount of capacity. The goal of engineering cost analysis is generally to determine the optimal method of building telecommunications facilities.

Economic Costs

- The objective of this costing perspective is to determine the structure of efficient prices, that is, prices that maximize consumer and producer surplus. Economic costing uses a forward-looking approach that emphasizes concepts of cost variability, incremental costs and opportunity costs. These concepts are discussed below.

should be recovered (e.g. through prices, etc.) from the source that caused the costs to be borne. While this principle is relatively easy to implement in many instances (variable or incremental costs), it is more complex to apply in the presence of fixed, joint and shared costs. We discuss this issue in more detail below in the section containing the interconnection pricing example.

One of the most important distinctions between costing methods is between methods that use historical data and ones that use a forward-looking approach. We adopt this distinction in our detailed discussion of costing methods in the following section. Generally, forward-looking costs are preferred because they better reflect the workings of competitive markets. In such markets, from the moment an investment is made, the asset's value to the operator depends more on what use can be made of it than what it cost. If a competitor is more efficient, the operator will need to respond by adjusting its prices, rather than to continue pricing on the basis of its historical costs. In other words, competitive operators are compelled to look forward to set prices, and hence be able to compete, rather than to look backward to prices based on their original investments.

Costing methods and models can be “top-down” or “bottom-up”. Top-down approaches are generally associated with historic costs, while bottom-up models are generally associated with forward-looking costs.

One matter that we have not dealt with so far is the cost of capital. The required return on investment in the network and other related assets is the cost of capital. It should reflect the opportunity cost to investors, so that the return earned on network assets and other related assets would be broadly equal to the likely return on alternative comparable investments.

Because the telecommunications industry is capital-intensive, the cost of capital is a critical issue in determining telecommunications costs, regardless of the costing methodology used. The main point to recall is that the regulator has to incorporate the correct measure of the cost of capital in its costing methodology in order for the regulated operator to recover all of its efficient capital costs, including its equity and debt costs.

1.4.3.1 Costing Method Comparison

This introductory section provides a graphical comparison of the main costing methods that are discussed in greater detail in the following sections.

Much of the controversy associated with cost analysis relates to the allocation of indirect costs to different telecommunications elements or services. The allocation issue is highlighted in Figure B-8 which provides a simplified comparison between LRIC, TSLRIC/LRAIC, TELRIC, FDC/FAC and stand-alone cost for a specific telecommunications element or service.

Recall from Box B-4 that LRIC, TSLRIC/LRAIC and TELRIC are generally required to be supplemented by mark-ups to recover a portion of joint and shared costs. Hence, mark-ups are included in Figure C-15 for those cost methods. This is in contrast to FDC/FAC approaches that generally allocate all joint and common costs to the services, based on allocation formulae. In this instance, there is no requirement for mark-ups. Recall that if all joint and shared costs are included, the resultant cost concept is stand-alone cost. We discuss the allocation issue further in the section that contains the interconnection cost analysis example.

Box B-4: Principal Costing Terms and Concepts (in alphabetical order)

Allocated Cost - A joint or common cost that has been divided among services in accordance with a set formula or by judgement. This is also known as a distributed cost.

Average Cost - A specified cost divided by the quantity of output. [By default, usually refers to the average of total cost, which is total cost divided by the specified volume of output.]

Avoidable Cost - A cost that would not be incurred if output volume was reduced.

Common Cost - A cost incurred when a production process yields two or more services. This is also referred to as shared cost if it applies to all of the operations of the operator. For example, the cost of the building to house a telecommunications exchange may be described as a common cost of serving both business and residential customers. The salary of the operator's president may be considered a shared cost of all services (this type of cost is often also referred to as an "overhead" cost).

Direct Cost - A cost that can be attributed solely to the production of a specific item. A direct cost does not require a cost allocation (or distribution) to separate it from the costs incurred in the production of other items. An indirect cost, however, does require such an allocation. An operator that produces a single product sold in a single market incurs only direct costs. When an operator is engaged in producing multiple products or serving multiple markets, however, it will normally also incur indirect costs such as joint and/or common costs.

Fixed Cost - A cost that does not vary by volume of production. A specific type of fixed cost is sunk costs, costs that cannot be changed or avoided even by ceasing production entirely. For instance, head office space is a fixed cost, but the labour component of the installation of the copper wire in the local loop is a sunk cost. Neither fixed nor sunk costs enter into marginal-cost pricing decisions because neither varies with output.

Increment - A specific non-minimal increase or decrease in volume of production.

Incremental Cost - The change in total cost resulting from an increment. Incremental cost equals total cost assuming the increment is produced, minus total cost assuming the increment is not produced. Because a wide variety of different increments can be specified, incremental cost can conceptually range all the way from total cost per unit (entire output as the increment) to marginal cost (one unit as the increment). The size of the increment used in any specific cost analysis will be a matter of judgement. The most common practice is to use the entire service or element as the increment, in which case the service or element specific fixed costs of the service or element would be included in the increment

Box B-4: Principal Costing Terms and Concepts (in alphabetical order) (cont'd)

Joint Cost – A specific kind of common cost incurred when a production process yields two or more outputs in fixed proportion. Joint costs vary in proportion to the total output of the joint production process, not to the output of the individual joint products.

Long Run – A period over which all factors of production, including capital, are variable. In practice, a period of 10 to 15 years is sometimes selected by regulators for the purpose of LRIC analysis, for example.

Long Run Incremental Cost (LRIC) – The incremental costs that arise in the long run with a specific increment in volume of production. LRIC is generally calculated by estimating costs using current technology and best available performance standards. When a cost study is based on the “costs of an efficient firm”, it usually refers to LRIC-type methodology. In the presence of joint or common costs, the sum of the LRIC for all of the operator’s services will be less than the total costs of the operator. Hence, the operator will not be able to recoup all of its costs. Regulators will generally allow a mark-up to be added to LRIC or LRIC-type costs for the firm to help recover all of its costs.

Marginal Cost – The change in total cost resulting from a very small change in the volume of output produced. Due to a number of practical issues, including the lumpiness of capital increments (i.e. the inability of telecommunications plant to be divided into very small parts, or scaled to provide an exact fit with the actual requirements of the network), marginal cost is difficult to estimate. Accordingly, most estimates of marginal cost are based on incremental cost.

Mark-Up – A percentage or a fixed monetary amount that is used to take into account joint and common costs, for example, to supplement certain costing methodologies. Cost concepts that do not fully allocate (or distribute) all indirect costs generally require mark-ups. These cost concepts include incremental costing methodologies, including LRIC (and TSLRIC/LRAIC and TELRIC as discussed in detail in the cost methods section below). The mark-up may be uniform or non-uniform. While regulators have generally set uniform mark-ups to promote competition, the application of Ramsey principles suggests that a non-uniform mark-up may be economically efficient.

Stand-alone Cost – The total cost to provide a particular product or service in a separate production process (i.e. without benefit of scope economies).

Total Cost – The aggregate amount of all costs incurred in producing a specified volume of output. The sum of fixed and variable costs equals total cost.

Variable Cost – A cost that varies with increased volume of production.

Source: Adapted from Johnson (1999) and other sources.

1.4.3.2 Historical Cost Approaches

These approaches generally involve the compilation and analysis of accounting and other historical data. One of the advantages of these approaches is that they reflect the real-world workings of the actual telecommunications operator under study.

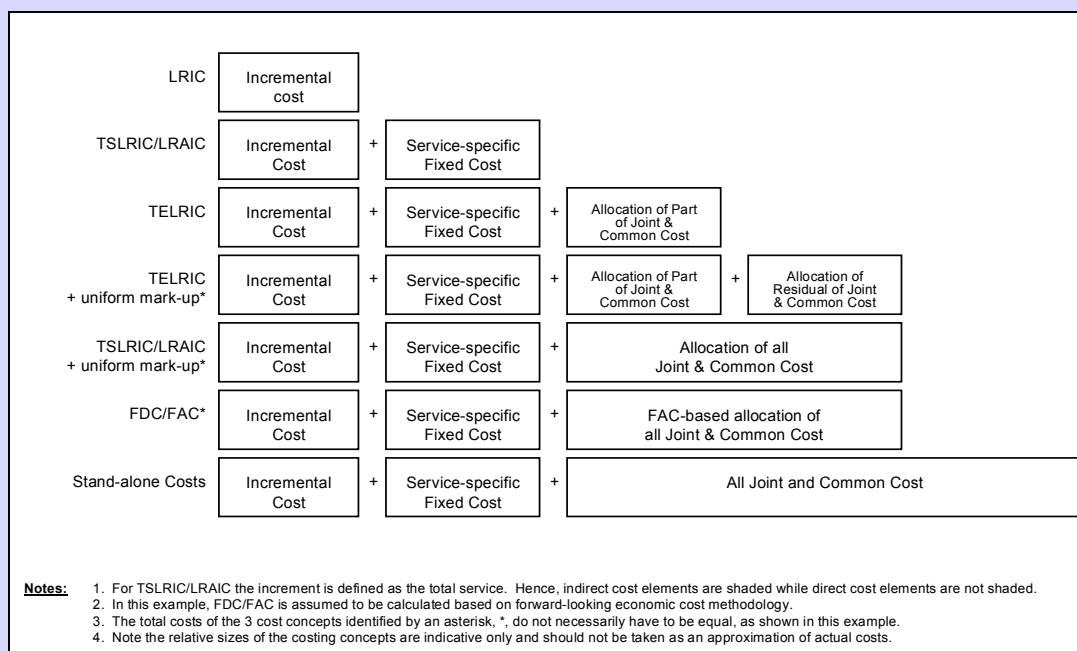
Fully Distributed Cost (FDC)

- This method, also referred to as fully allocated cost (FAC), is generally based on a historical accounting of costs. Typically, an FDC study

focuses on broad categories of service rather than on individual services. For instance, the study might show the cost of local exchange service, different lengths of long distance and miscellaneous services.

- The challenge (and inherent weakness) of this type of study is how to allocate joint and common costs to the specific classes of services. The joint and common costs are often allocated to the various categories of service using formulas that reflect relative usage or other factors.

Figure B-8: The Relationship Between Costs, Costing Methods and Allocations



Source: Adapted from ODTR (1999) and other sources.

- For instance, if network access lines in an exchange are used 70% for local calls, 20% for national long distance calls and 10% for international calls, an FDC study may allocate the joint costs of these lines based on the same percentages. These allocations are arbitrary.
- FDC/FAC methods do not require a mark-up to recover a portion of joint and common costs. The FDC/FAC allocation may or may not be the same as the one that would result from the use of a mark-up.
- Another criticism of this type of study is that the historic costs may reflect certain operational or technological inefficiencies of the incumbent operator. Using historic costs, for example to calculate interconnection costs, leads to concerns that incumbent operators are “passing on their inefficiencies” to the interconnecting operators. The reason for this is that the services in question could likely be provided at a

lower cost using current technology or efficient labour and/or management practices.

Embedded Direct Analysis (EDA)

- This is also a type of study based on historical accounting of costs, but it differs from FDC. An EDA study will only assign those costs that can be directly traced to a particular service category. Joint and common costs will be left unassigned, typically as one or more lump sum amounts.

1.4.3.3 Forward-Looking Cost Approaches

These approaches typically involve the development of engineering-economics models that are used to calculate the costs of network elements and, in turn, services provided using those elements. These models estimate the costs of rebuilding specific elements of the network using current technology. Generally, this modelling approach assumes

operating and capital costs will be incurred efficiently. The LRIC approach is discussed in Box B-4.

Total Service Long Run Incremental Cost (TSLRIC)

- TSLRIC measures the difference in cost between producing a service and not producing it. TSLRIC is LRIC in which the increment is the total service. Hence, mark-ups are required to recoup a portion of joint and common costs, which are not included in TSLRIC.
- The European Commission has adopted a TSLRIC-type approach, called, Long Run Average Incremental Cost (LRAIC) as its preferred costing methodology. The term “average” is intended to capture the policy decision that defines the increment as the total service. LRAIC, hence, includes the fixed costs specific to the service concerned: “service-specific fixed costs.”
- TSLRIC can be useful in public policy and pricing decisions. For example, TSLRIC estimates can highlight the presence or absence of subsidies for a service. Similarly, incremental costs can be useful in developing or examining the regulatory or pricing policies that apply to a particular service or group of customers.
- One of the weaknesses of this method, and of all forward-looking studies, is that the results are estimations that may or may not occur in practice.

Total Element Long-Run Incremental Cost (TELRIC)

- TELRIC is a term coined by the FCC to describe a specific approach to costing. TELRIC includes the incremental cost resulting from adding or subtracting a specific network element in the long run, plus an allocated portion of part of the joint and common costs. Hence, mark-ups may also be necessary to recoup a portion of the “residual” joint and common costs not already included in TELRIC.

- The FCC developed TELRIC to implement the 1996 Telecommunications Act. In the FCC’s words:

...prices for interconnection and unbundled elements...should be set at forward-looking long-run economic cost. In practice, this will mean that prices are based on the TSLRIC of the network element, which we will call ...TELRIC, and will include a reasonable allocation of forward-looking joint and common costs...

- In coming up with its own costing method, the FCC distinguished between its approach to costing network elements and TSLRIC.
- The FCC required that certain joint and common costs be included in TELRIC, even if they do not vary with the presence or absence of the element in question. This is not consistent with the standard definition of TSLRIC.

1.4.4 Interconnection Costing Example

This section provides a numerical example of a forward-looking costing analysis to determine an interconnection price. This example incorporates many of the concepts introduced in this Appendix. Note, however, that it deals only with the on-going costs of interconnection. It does not include the “start-up” costs associated with actually interconnecting the two operators (transmission links, etc.). These “start-up” costs, which can be relatively small compared to the “ongoing” or “recurrent” costs discussed in this example, are discussed in Module 4.

Figure B-9 provides a simplified graphical representation of the costs of an incumbent operator that provides access services and local calling services. The specific division between access and calling service costs varies depending on the purpose of the cost analysis. Generally, access service costs include costs of the local loop and some associated fixed costs. Calling service costs generally include those associated with the rest of the network, including switching and transmission. Note that “calling” services are referred to as conveyance in the UK and other countries.

1.4.4.1 Determining the Size of the Increment

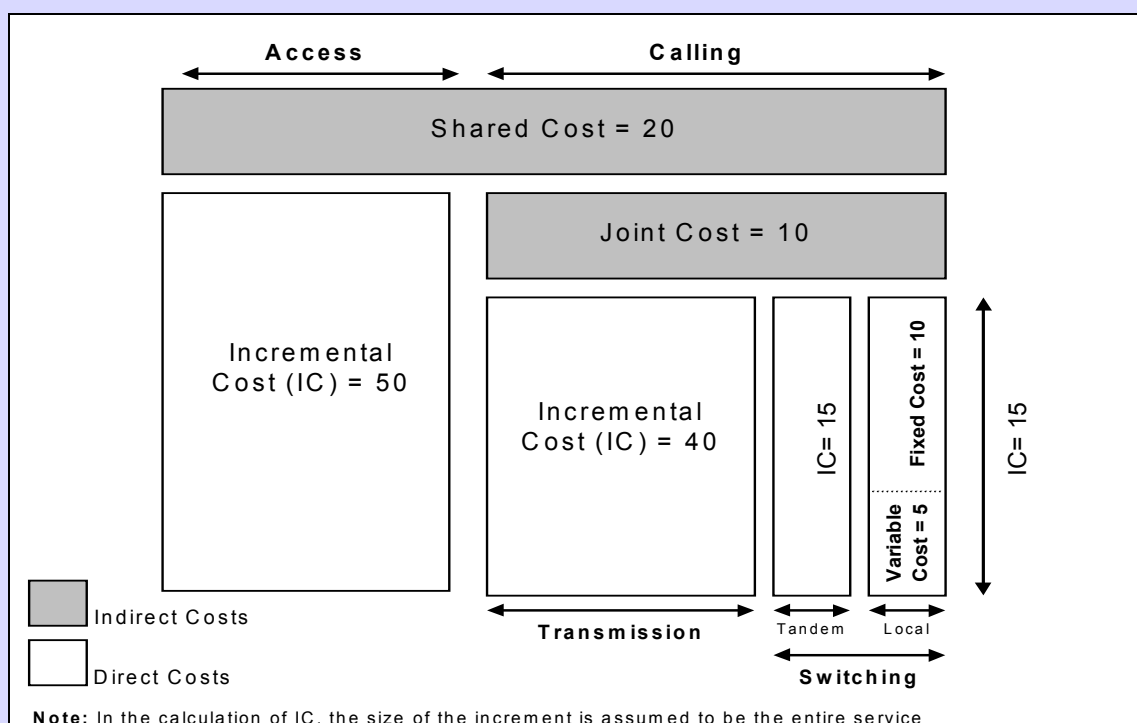
In this example, we generally assume that the size of the increment is the entire service. This assumption is consistent with the principle of cost causation as it has been interpreted by many regulators. This assumption means that the service-specific fixed costs of each service are included in calculation of the respective incremental costs. In practice, this assumption will mean that the entrant makes a contribution to the incumbent operator's service-specific fixed cost.

As shown in Figure B-9, the incremental costs for access, transmission, tandem switching and local switching are 50, 40, 15 and 15. Local switching may be further disaggregated into fixed costs of 10 and variable costs of 5.

Total incremental costs are 120. These costs constitute the incumbent operator's direct costs. The indirect costs total 30 and include joint cost of 10 (e.g. carrier services or network division, etc.) and shared cost of 20 (e.g. president's salary, etc.).

In this example, we assume that a long-distance operator requests interconnection with the incumbent (access and local) operator at the local switch. Let us assume that the parties do not agree on interconnection price, or that the regulator wishes to provide interconnection pricing guidelines in advance. What is the appropriate interconnection amount? This question is addressed in the following sections.

Figure B-9: Interconnection Costing Example: Analysis of Access and Local Calling Networks



1.4.4.2 LRIC Approach

Based on a narrow application of the principle of cost causation, the entrant should pay the incumbent operator only for the additional costs that result from the entrant terminating and originating traffic on the latter's network. Based on the LRIC methodology, therefore, the entrant should pay the incumbent operator only a proportion of the variable cost of the local switch. That proportion may be based on market share or other criteria. For instance, the proportion could be the percentage of entrant minutes routed on the incumbent operator's network. For this example, we assume the entrant has a 10% market share. Using this methodology, the regulator would set an interconnection amount of 0.5. This amount is based on the proportion (10%) of the variable cost of local switching (5).

Based on this perspective, the entrant does not cause the incumbent operators to bear any other additional costs, and should therefore pay only the amount indicated above. The LRIC approach does not include service-specific fixed cost or joint and shared costs. These cost concepts are discussed in the sections below.

Note that the entrant is not required to pay for the use of the incumbent operator's access services. This is because these are traditionally considered as fixed with respect to the volume of traffic. Hence the entrant does not cause any additional access cost to the incumbent operator. Most telecommunications economists suggest that the costs of access services (including the local loop) should generally be recovered from the incumbent operator's subscribers through connection and subscription prices.

Given that the entrant is requesting interconnection at the local switch, it is not using the incumbent operator's transmission or tandem switching services and hence should not have to pay for them.

Regulators have not generally set the interconnection amount charges solely on LRIC. Interconnection prices based only on LRIC will generally be lower than those based on other costing methodologies. Such low prices may promote market entry. Prices based solely on LRIC are generally considered to be too low, and to not adequately compensate the

incumbent operator for the use of its network. Such rates will generally not provide sufficient compensation for the incumbent operator to properly maintain its network and to build additional needed infrastructure.

1.4.4.3 TSLRIC/LRAIC Approaches

The LRIC approach discussed above does not include service-specific fixed costs. The fixed costs of the local-switching services (10) are being borne wholly by the incumbent operator. Most regulators have established that the size of the increment should be set as the entire service. This issue was discussed in section 1.4.4.1.

Under the TSLRIC/LRAIC approaches, the regulator would set an interconnection charge of 1.5. As indicated in Figure C-15, this charge is made up of LRIC plus a proportion (for example 10%, equal to the entrant's market share) of the service-specific fixed cost of the local switch (10).

1.4.4.4 Allocation of Joint and Shared Costs: Mark-ups

The TSLRIC/LRAIC approach does not include any of the joint and shared costs of the incumbent operator. Generally, most regulators have determined that the interconnection amount should include a component that accounts for an allocated part of joint and shared costs. This has traditionally been implemented by including a mark-up to supplement TSLRIC/LRAIC.

This situation is analogous to that discussed in the natural monopoly pricing section. In that section we found that marginal cost is below average costs, and setting a regulated price equal to marginal cost will not allow the operator to recoup all of its costs. In order for the operator not to lose money and go out of business, the regulator had to set at least some prices above marginal costs. The sum of all the "mark-ups" over marginal should be set so that the operator could break even.

Similarly, in our example, the regulator should be concerned that the incumbent operator is able to recoup all of its forward-looking costs, including joint and shared costs. The issue is one of overall cost recovery. If no mark-up is included in the

interconnection amount, the incumbent operator will have to recoup all of its joint and shared cost from its own customers and/or other entrants. Many regulators have determined that this would not be a fair and equitable distribution of these indirect costs.

The mark-up may be uniform or non-uniform. Regulators have generally set uniform mark-ups. In our example, a uniform percentage mark-up would be 20%. This is calculated as the percentage of indirect cost (30) to the total costs (150) of the firm. Applying the 20% mark-up on the TSLRIC/LRAIC amount would result in an interconnection amount of 1.8.

As noted in Box B-4, Ramsey principles would suggest that a non-uniform mark-up, based on the inverse-elasticity rule, may be more economically efficient than a uniform mark-up. Regulators have not generally adopted such an approach.

1.4.4.5 Structure of Interconnection Prices

Note that in our example we have referred to interconnection amounts. These amounts are similar to the revenue requirement concept introduced in Module 4. That is, the interconnection amount constitutes the total monetary sum to be paid over a certain period. This is not the same as interconnection prices or rates. These relate to the manner in which the interconnection amount is recovered. We also refer to this issue as the structure of interconnection prices. The structure of interconnection prices is an important matter that will have an impact on the economic and administrative efficiency of the entire interconnection regime.

For any specific interconnection amount, there are a number of alternate pricing structures. For example, interconnection prices may be set based on one or a combination of the following:

- Usage-based (e.g. minutes, calls, etc.);
- Fat-rated (fixed amount per period, independent of usage);
- Time-of-day (peak and off-peak, etc.);
- Network functionality (call set-up and call duration, etc.); and
- Capacity-based (fixed available capacity, measured in bandwidth, E1's, T1's, etc.).

Generally, the structure of interconnection prices should reflect the underlying cost structure, if this is known. The price structure should also be relatively easy to implement and administer and should ensure adequate cost recovery.

For instance, in the TSLRIC/LRAIC plus uniform mark-up discussion above, the total interconnection amount was determined at 1.8. Recall that the local switch had a fixed cost of 10 and a variable cost of 5, a 2:1 relation between fixed and variable costs. Hence, one option is to have flat-rated pricing to recoup the fixed cost component of the interconnection amount, 1.2 and usage-based pricing to recoup the variable cost component, 0.6. Flat-rated prices could include fixed monthly charges for the number of ports used by the entrant in the incumbent's local switch or other alternatives. Usage-based prices could include per minute or per call charges for the entrant's calls.

Note that in practice most regulators have adopted usage-based pricing only. In our example the entire interconnection amount of 1.8 would be collected by per minute or per call charges. This decision has generally been based on a number of factors, including administrative efficiency. Pricing based on usage only is also recommended when the regulator is uncertain of the relation between fixed and variable costs.

APPENDIX C - GLOSSARY

Note: This glossary includes terms commonly used in telecommunications regulation and the telecommunications business generally. Definitions are adapted from non-definitive reference sources, including ITU reports (see sources note). The definitions have no official status. Terms in *italics* are defined elsewhere in the Glossary.

Abuse of Dominance - Conduct by a firm, made possible by its dominant position in a market (see Dominance and Market Power), that is or may be harmful to competition in that market. The concept of abuse of dominance is a broad and evolving one that covers different types of conduct. Examples include anti-competitive cross-subsidization, and vertical price squeezing. (See Module 5.)

Access charge – A form of interconnection payment, usually consisting of an amount per minute, charged by network operators for the use of their network by other network operators. (See Module 3)

Access Deficit Charge (ADC) – Mechanism used to finance universal service in competitive markets. New operators typically pay ADCs to subsidize incumbent operators for the deficit they incur in providing local access services that are priced below cost. (See Module 6.)

Agreement on Basic Telecommunications (ABT) – This World Trade Organization (WTO) agreement came into effect on 1 January 1998. Properly cited as the Fourth Protocol to the General Agreement on Trade in Services, this agreement is discussed in Module 1. See also the entry below for the *WTO Regulation Reference Paper*, which is reproduced in Appendix A.

Advanced Mobile Phone System (AMPS) - An analogue cellular telephone service standard utilizing the 800 to 900 MHz band (and recently also the 1800-2000 MHz band).

Air time - The minutes of calls a subscriber makes from a mobile phone. Also referred to as talk time.

Allocated Cost - A joint or common cost that has been divided among services in accordance with a set formula or by judgement. This is also known as a distributed cost. (See Appendix B: The Economics of Telecommunications Prices and Costs)

Amplifier - Device used to boost the strength of an electronic signal over an analogue transmission facility.

Analogue - Analogue signals carry information in continuous, varying electrical waves. Analogue was the original recording and transmission technology (preceding digital technology). It is still used in many communications applications.

Asynchronous Transfer Mode (ATM) - A method to send data packets at irregular intervals by preceding each packet with a starter bit and following the data packet with a stop bit. It is asynchronous in the sense that time between packets varies.

Asynchronous Transmission - Transmission of data over a network in which each character of information is individually synchronized by means of a start and stop bit to provide character framing. The time between characters may vary (see ATM).

Automatic Number Identification (ANI) – Application able to transmit and display the telephone number of the calling party to the party answering the call. (See also *Calling Line Identification*)

Average Cost - A specified cost divided by the quantity of output. [By default, usually refers to the average of total cost, which is total cost divided by the specified volume of output.] (See Appendix B: The Economics of Telecommunications Prices and Costs)

Avoidable Cost - A cost that would not be incurred if output volume was reduced. (See Appendix B: The Economics of Telecommunications Prices and Costs)

Backbone Network - A network that links smaller or lower-speed networks.

Bandwidth - The range of frequencies that can pass along a transmission line or other medium. In analogue systems it is measured in terms of Hertz (Hz) and in digital systems in bit/s per second (bit/s). The higher the bandwidth, the greater the amount of information that can be transmitted at the same time. High bandwidth channels are referred to as broadband which typically means 1.5/2.0 Mbit/s or higher.

Bandwidth on demand - Capability of an end user or network device to access available network capacity at a rate as required by the application being utilised for a specified period.

Base station - A radio transmitter/receiver and antenna used in the mobile cellular network. It maintains communications with cellular telephones within a given cell and transfers mobile traffic to other base stations and the fixed telephone network.

Basic telecommunications service – Generally refers to voice telephony service, though some definitions also include telex and telegraph services.

BDT – ITU Telecommunication Development Bureau. (See Module 1 for description of the ITU)

Best effort - The service model for standard Internet service. In the face of congestion of a network interface, packets are discarded without regard to user or application until traffic is reduced.

Bill and Keep – Interconnection arrangement where no charges are payable between interconnecting operators for termination of each other's traffic. (Another term for *Sender Keep All*; See Module 3).

Bit ("Binary Digit") - A bit is the primary unit of electronic, digital data. Written in base-2, binary language as a "1" or a "0".

Blocking - The inability to complete a call because all possible paths between the calling station and the destination are already in use. Users are alerted to this condition through a busy signal.

Bps - Bits per second is a measure of the rate of data communications representing the number of bits transmitted every second. (10 **Mbps** (Megabits)

= 10 million bits per second; 10 **Gbps** (Gigabits) = 10 billion; 1 **Tbps** (Terabits) = 1 trillion)

Broadband -. Broadband communications use transmission media with a large bandwidth such as wireless, coaxial or fibre-optic cable. This allows transmission at higher speeds (bps). Broadband transmission techniques can permit more than one device to transmit at the same time using different frequencies. Services provided include video, voice and additional data channels.

Build-Operate-Transfer (BOT) - A project whereby a private company is awarded a concession to build a telecommunications network or service and operates it for a certain period of time before handing over ownership to the national telecommunication administration or PTO. (See Module 2)

Build-Transfer-Operate (BTO) - A project whereby a private company is awarded a concession to build a telecommunications network or service, hands over ownership to the national telecommunication administration or PTO, and operates it for a certain period of time. (See Module 2)

Byte - (1) A set of bits that represent a single character. A byte is composed of 8 bits. (2) A bit string that is operated upon as a unit and the size of which is independent of redundancy or framing techniques.

Calling Line Identification (CLI) - Relies on ANI to capture and use the telephone number of a calling party for various purposes (e.g. calling line identification display, or call blocking).

Calling Party Pays (CPP) – The billing option whereby the person making the call is charged. This is in contrast to billing the recipient of the call. Calling party pays is the norm on fixed telephone networks and is used for an increasing number of mobile networks.

Carrier – See *Common Carrier*. This term is also used to describe the presence or absence ("no carrier") of information on a cable or other transmission medium.

CCITT - Comité Consultatif Internationale de Télégraphique et Téléphonique (International Consultative Committee on Telephones and

Telegraphs). The former name of ITU-T, CCITT was the primary international standards body for telecommunications. (See description of ITU in Module 1).

CCSS7 - See *Signalling System Number 7*.

Cell - The geographic area covered by a single base station in a cellular mobile network.

Cellular - A mobile telephone service provided by a network of base stations, each of which covers one geographic cell within the total cellular system service area.

Central Office - Location where local subscriber loops are controlled, connected and switched to other destinations in the public switched network system. Central Office is the term used in North America for a local telephone Exchange (see below). In addition, the term “Central Office” is frequently used as a synonym for the switching equipment itself.

CEPT - Committee of European Post and Telephone (See Table of International Organizations, Module 1).

Channel – (1) A path for electrical transmission. Also called a *circuit*, line, link or path. (2) A specific and discrete bandwidth allocation in the radio frequency spectrum.

Circuit - A telecommunications channel established between two or more points, allowing the exchange of sources information between these points.

Circuit Switched Connection - A temporary connection that is established on request between two or more terminals (stations) in order to allow the exclusive use of that connection until it is released.

Coaxial Cable – A type of electrical communications cable used to provide cable television and also used in the LAN environment in other networks. Coaxial cable consists of an outer conductor and an inner conductor, separated from each other by insulating material, and covered by some protective outer material. This medium offers large bandwidth, supporting high data rates with relatively high immunity to electrical interference and a low incidence of

errors. Coaxial cable is subject to distance limitations and is relatively expensive and difficult to install.

Code Division Multiple Access (CDMA) - A technology for digital transmission of radio signals based on spread spectrum techniques where each voice or data call uses the whole radio band and is assigned a unique code. Used in cellular and other wireless mobile services.

Collocation - Facility-sharing in which an operator, often an incumbent operator, provides space in its switching exchanges or other premises for communications equipment, such as transmission cables, of competitive operators to facilitate interconnectivity to end-users. (See Module 3.)

Common Carrier - A North American term for a telecommunications operator that provides public telecommunications services, including access to the public switched telecommunications network and telecommunications transport services.

Common Cost - A cost incurred when a production process yields two or more services. This is also referred to as shared cost if it applies to all of the operations of the operator. For example, the cost of the building to house a telecommunications exchange may be described as a common cost of serving both business and residential customers. The salary of the operator's president may be considered a shared cost of all services (this type of cost is often also referred to as an “overhead” cost) (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Competitive Local Exchange Carrier (CLEC) - Term originating in North America to identify a new entrant in the local exchange network services market. It generally competes with an *ILEC*.

Connectivity - The capability to provide, to end users, connections to the Internet or other communications networks.

Corporatization - Corporatization involves legal changes to grant a government-owned telecommunications operator administrative and financial autonomy from the central government.

Cross-subsidy – Covering the cost of offering some services through excess revenues earned from other services. In telecommunications, the term “anti-competitive cross-subsidy” normally refers to a practice by a dominant firm of offering services in competitive markets at low (e.g. below-cost) prices, while maintaining overall firm profitability by charging above-cost prices in monopoly markets, or in other markets where the firm enjoys *Market Power*. (See Module 5).

Customer Premises Equipment (CPE) - A term developed in North America to describe any apparatus from PBX switching systems to telephone handsets that are located on the customer's premises, rather than on the telephone company's premises. The term CPE is commonly used to refer to equipment that is owned by the customer (end user).

Dedicated Access Lines – Telecommunications lines dedicated to or reserved for use by particular users along predetermined routes. They interconnect a switching system to a dedicated customer and may be connected to specific telephone, *key telephone system* or *PBX*. Also referred to simply as “dedicated lines”.

Dial Tone - A signal heard when the telephone handset is off-hook, indicating that the exchange or PBX is ready to accept and process a dialled number.

Dial Tone Delay - Refers to the time it takes to obtain a dial tone after a telephone handset is taken off hook. Average dial tone delay is a common measure of service performance quality.

Digital - A communications technique in which sound is represented as discrete *Bits*. The digits are transmitted as a series of pulses. Digital transmission differs from analogue transmission in that digital technology converts analogue sounds or electrical signals into the *Bits*, which can be transmitted without distortion or need of amplification. Digital networks allow for higher capacity, greater functionality and improved quality. GSM, CDMA and TDMA networks are all digital. The Internet is also a digital network.

Digital Network - A telecommunication network in which information is converted into a series of distinct electronic pulses and then transmitted as a digital bit stream (see also *Digital* and *Analogue* network).

Digital Signal Level 1 (DS1) - Digital Signal level 1 refers to a digital hierarchy of circuits or channels operating at 1.544. This corresponds with the North American and *Japanese T1* designation.

Direct Cost - A cost that can be attributed solely to the production of a specific item. A direct cost does not require a cost allocation (or distribution) to separate it from the costs incurred in the production of other items. An indirect cost, however, does require such an allocation. An operator that produces a single product sold in a single market incurs only direct costs. When an operator is engaged in producing multiple products or serving multiple markets, however, it will normally also incur indirect costs such as joint and/or common costs. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Domain Name - The registered name of an individual or organization eligible to use the Internet. Domain names have at least two parts and each part is separated by dot. The name to the left of the dot is unique for each top-level domain name, which is the name that appears to the right of the dot. For instance, The International Telecommunication Union's domain name is *itu.int*. “ITU” is a unique name within the gTLD “*int*”.

Dominance – An extreme form of *Market Power*. (See below) While the definition of market dominance varies with the laws of different countries, a finding of dominance usually requires proof of a relatively high market share and the existence of significant barriers to entry into the markets in which a firm is dominant. (See Module 5.)

Download - The process of loading software or files from one device to another across a network.

Dual Tone Multi-Frequency (DTMF) - A method of signalling initiated from the pushbutton touch-tone keys of the telephone. The exchange recognizes each digit dialled by the caller by means of a unique frequency generated by the touch-tone keys. DTMF

is used for many value-added features, such as voice-mail, tele-ordering and automated response software.

E-1 - A European and international digital standard referring to any transmission line or connection operating at the rate of 2.048 Mbps. (See also T-1 for a description of the comparable North American standard.)

Electromagnetic Interference (EMI) - Interference caused to telecommunications signals by electromagnetic radiation.

Electronic Data Interchange (EDI) - EDI is the computer-to-computer exchange of business documents between companies, using a public standard format. Rather than preparing paper and sending it through the mail, or using other communications methods such as fax, EDI users exchange business data directly between their respective computer systems.

Electronic Mail (E-Mail) - Host computer or LAN-based electronic mail systems employ software-defined "mail boxes." Other computer terminals can access the E-mail program to view, answer, broadcast, delete, forward, or file E-mail message text and images.

Encryption - The translation of data into a secret code. Encryption is the most effective way to achieve data security. To read an encrypted file, one must have access to a secret key or password that enables it to be decrypted.

End User - The individual or organization that originates or is the final recipient of telecommunications messages or information (i.e. the consumer).

Enhanced services – Telecommunications services provided over public or private networks which, in some way, add *value* to the basic carriage, usually through the application of computerized intelligence, for instance, reservation systems, bulletin boards, information services. Also known as *Value Added Services*.

Equal Access – The ability of telecommunications users to access the services offered by new entrants

as easily as to those of incumbent operators. (See Module 3.)

Essential Facilities - In telecommunications regulation, this term generally refers to facilities associated with a telecommunications network or service that are exclusively or predominantly provided by a monopolist or a small number of suppliers, and that cannot feasibly be substituted by competitors for economic or technical reasons. The concept of *Essential Facilities* is discussed in detail in Modules 3 and 5.

Exchange - The term *Exchange* is generally used to refer to Switches that are connected to the PSTN. Local exchanges connect local loops from end users to trunks which are connected to other exchanges, including tandem exchanges and international gateway exchanges, all of which are different types of switches. In North America, the term Central Office is usually used to refer to a local *Exchange*. In some countries, including those in North America, the term *Exchange* or *Exchange Area* refers to the local area served by one or more local *Exchanges*. (See also definition of *Switch*.)

Exchange Point - Points within a network at which IP packets are exchanged between ISPs.

Extranet - An Extranet is an *Intranet* that is partially accessible to authorized outsiders through the use of passwords.

Facilities-based Operator - A *PTO* that operates its own network transmission facilities (wires, cables, microwave routes, radio transmitters and receivers, satellite transponders, etc.). A facilities-based operator is usually contrasted with a "*Reseller*" (see definition below).

Fibre Optics - A technology that uses pulses of light as a digital information carrier, transmitted through thin strands of glass. *Fibre Optic Cable* is a transmission medium composed of such glass strands. Fibre optic cable provides higher transmission rates than wire or co-axial cable and is immune from electrical interference.

Fixed Cost - A cost that does not vary by volume of production. A specific type of fixed cost is sunk costs, costs that cannot be changed or avoided even

by ceasing production entirely. For instance, head office space is a fixed cost, but the labour component of the installation of the copper wire in the local loop is a sunk cost. Neither fixed nor sunk costs enter into marginal-cost pricing decisions because neither varies with output. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Fixed Line - A physical line connecting the subscriber to the telephone exchange. Typically, *fixed-line network* is used to refer to the *PSTN* (see below) to distinguish it from mobile networks.

Frame Relay - A fast packet switching technology that eliminates much of the processing and delay of traditional X.25 packet switching.

Frequency - The number of cycles per second at which an analogue signal electrical current alternates, usually measured in Hertz (Hz). One Hertz is one cycle per second. It is also used to refer to a location on the radio frequency spectrum, such as 800, 900 or 1800 Mhz.

Fully Distributed Costs (FDC) - Approach for allocating telecommunications costs to different telecommunications services (also referred to as “fully allocated costs”). This approach is usually based on an allocation of historical accounting of costs to various broad service categories. After assigning direct costs to each category, the Joint and Common Costs are allocated to applicable service categories based on formulas that reflect relative usage or other factors. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Gateway - Any mechanism for providing access to another network. This function may or may not include protocol conversion.

GATS - General Agreement on Trade-In Services (See Module 1 and WTO)

Gbps - Billion *bits* per second.

General Packet Radio Service (GPRS) - An enhancement for GSM, based on packet-switched technology enabling high-speed data transmission (115 kbit/s per second).

Gigabit - One billion *bits*.

Global System for Mobile communications (GSM) - European-developed digital mobile cellular standard. For more information, see the GSM Association website at <http://www.gsmworld.com/index.html>.

Graphic User Interface (GUI) - A computer terminal interface that employs a bit-mapped screen. Graphical interfaces typically have Windows, Icons, Mice, Menus and Pointers. The GUI permits mixed graphics and text, and incorporates easy-to-use visual representations of system functions. The GUI was popularized in personal computing, with the introduction of the Apple *Macintosh* computer, and later with Microsoft's *Windows* operating system.

Half-Circuit - A component of an international circuit between two countries that originates in one country and terminates at a theoretical midpoint between the countries.

Hand-off - A central concept of cellular technology, enabling mobility for subscribers. It is a process by which the *Mobile Telephone Switching Office* passes a mobile phone conversation from one radio frequency in one cell to another radio frequency in another as a subscriber crosses the boundary of a cell.

Head-End - The point in a broadband network that receives signals on one set of frequency bands and retransmits them on another set. The head end of a cable TV network generally receives satellite, off-air and wireline TV and multimedia signals, and retransmits them to end users through a fibre optic or co-axial cable distribution network.

Hertz (Hz) - The frequency measurement unit equal to one cycle per second.

High Speed Circuit Switched Data (HSCSD) - An intermediary upgrade technology for GSM based on circuit-switched technology and enabling data service speed of 57 kbps.

Host - Any computer that can function as the beginning and end point of data transfers. Each Internet host has a unique Internet address (IP address) associated with a domain name. A host

computer provides services such as database access, computation or other processing, and special programs or other content. A host computer is the primary or controlling computer in a multiple computer installation.

HTTP - HyperText Transport Protocol (see WWW).

IEEE - Institute of Electrical and Electronic Engineers. An international standards-setting organization.

IETF - Internet Engineering Task Force. An organization responsible for updating and maintaining TCP/IP standards.

IMT-2000 - *International Mobile Telecommunications*. The ITU third generation mobile cellular standard. For more information see the website at <http://www.itu.int/imt>.

In-Band Signalling - A communications technique used between switches and communications equipment in which the control signals are exchanged within the standard bandwidth of the telecommunications signal.

Increment - A specific non-minimal increase or decrease in volume of production. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Incremental Cost - The change in total cost resulting from an increment. Incremental cost equals total cost assuming the increment is produced, minus total cost assuming the increment is not produced. Because a wide variety of different increments can be specified, incremental cost can conceptually range all the way from total cost per unit (entire output as the increment) to marginal cost (one unit as the increment). The size of the increment used in any specific cost analysis will be a matter of judgement. The most common practice is to use the entire service or element as the increment, in which case the service or element specific fixed costs of the service or element would be included in the increment. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Incumbent Operator - The established telecommunications network operator(s) in a country. Normally the entity that operates all or most of the PSTN infrastructure in a country. In many countries this was the Posts, Telephone and Telegraph (PTT) administration of the national government. In some countries it was or now is a private sector operator. In both cases, incumbent PTOs generally operated as monopolies. (See also definition of PTO).

Incumbent Local Exchange Carrier (ILEC) - Term originating in North America to identify the incumbent operator that runs the local exchange network. It is or was typically the dominant provider of local PSTN services. See also *Competitive Local Exchange Carrier*.

Inflation Factor - Variable included in a price cap formula to reflect or represent changes in the input costs of telecommunications operators. (See also *Price Cap*.) (See Module 4.)

Information infrastructures, Information superhighway - High-speed communication networks capable of carrying voice, data, text image and video (Multimedia) information in an interactive mode.

Integrated Services Digital Network (ISDN) - A set of CCITT standards that provides for the transport of digital voice, data, image and video services.

Interactive Voice Response (IVR) - A voice processing system that allows the storage and retrieval of digital data, including data in the form of the human voice, through user interaction with the touch-tone keys of the telephone. The IVR's pre-recorded voice commands guide the caller through a menu, and the caller responds by touching the appropriate numbered or lettered key(s).

Interconnection - The physical connection of telephone networks owned by two different operators in order to allow customers connected to different networks to communicate, to ensure the interoperability of services. (See Module 3)

Interexchange Carriers (IXC) - A term originating in North America to describe long-distance telecom-

munications operators that provide service between cities or other local exchange areas.

Interface - The logical or physical connection between two networks, systems or devices; the point of interconnection of two components and the basis on which they exchange signals according to some hardware or software protocol.

Internet - The collection of interconnected networks that use the Internet Protocols (IP).

Internet Backbone - The high-speed, high capacity lines or series of connections that form a major pathway and carry aggregated traffic within the Internet.

Internet Content Provider - A person or organization, that provides information via the Internet either with a price or free of charge.

Internet Exchange Point (IXP) – Refers to a *Network Access Point (NAP)* where connections are made to dedicated Internet backbone networks or where ISPs connect with one another. NAPs serve as data interchange points for backbone service providers. NAPs and Metropolitan Area Exchanges (MAEs) are generally referred to as public Internet Exchange Points (IXPs).

Internet Protocol (IP) Numbers - An IP number (also referred to as Internet address number) is the address of a host or other intelligent devices on the Internet. All servers and users connected to the Internet have an IP number.

Internet Service Provider (ISP) - ISPs provide end-users and other ISP access to the Internet. ISPs may also offer their own proprietary content and access to online services such as e-mail.

Intranet - An Intranet is a network, based on TCP/IP protocols, accessible only by an organization's employees, or other authorized users. Intranet websites are similar to other websites, but are surrounded by firewalls that prevent unauthorised access.

ISO - International Standards Organization - ISO promotes the development of standards for

computers and other products. It developed the OSI model for data communication.

ITU - International Telecommunication Union. (See Module 1 for a description of the ITU and its various components, including ITU-R, ITU-T and ITU-D.)

ITU-D - Telecommunication Development Sector of the ITU. (See Module 1 for description of the ITU.)

ITU-R - Radiocommunication Sector of the ITU. (See Module 1 for description of the ITU.)

ITU-T - Telecommunication Standardization Sector of the ITU. (See Module 1 for description of the ITU.)

Joint Cost - A specific kind of common cost incurred when a production process yields two or more outputs in fixed proportion. Joint costs vary in proportion to the total output of the joint production process, not to the output of the individual joint products. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Kbps - *Kilobits* per second.

Key Telephone System - A multi-line telephone system designed to provide shared access to several outside lines through buttons on the telephone set. It typically offers identified access lines with direct line terminations on a telephone set. The system is located on the user's premises and can operate independently or in conjunction with a *PBX*.

Kilobit - One thousand *bits*.

Layer - A conceptual level of network processing functions. In the OSI model, network processing is thought of as taking place in layers, from the physical transmission of data up to the issuing of an end-user command. Layers communicate only with those immediately above or below in the layer protocol stack, or with peer-level layers on other systems.

Leased Line - A point-to-point communication channel or circuit that is committed by the network operator to the exclusive use of an individual subscriber. Depending on the country, leased lines may or may not be permitted to interconnect with the *PSTN*.

Licence – A telecommunications licence generally refers to the authorization to provide telecommunications services or operate telecommunications facilities. A telecommunications licence usually defines the terms and conditions on which the licensee is authorized to operate and sets out its rights and obligations. (See Module 2.)

Licensing – Term used to refer to the administrative steps followed by an NRA or other licensing authority to issue a *licence*. (See Module 2.)

Line – It usually refers to the communications channel whereby end users connect to the *PSTN*. Also called a circuit, trunk or facility.

Local Area Network (LAN) - A communications network that provides high speed data transmission and a low error rate in connecting computers and other terminal devices, usually within relatively small areas. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines and radio waves. (See also *Wide Area Network*.)

Local Exchange Carrier (LEC) – The telecommunications operator that provides service to end users through its local exchanges, which are connected to the *PSTN*. (See also *ILEC* and *CLEC*.)

Local Loop - The transmission path linking end users (i.e. subscribers) to the nearest exchange. It generally consists of a pair of copper wires, but may also employ fibre-optic or wireless technologies. The local loop is sometimes referred to as the "last mile". (See also *unbundled local loop*.)

Long Run - A period over which all factors of production, including capital, are variable. In practice, a period of 10 to 15 years is sometimes selected by regulators for the purpose of LRIC analysis, for example.

Long Run Average Incremental Costs (LRAIC) – A variation on *LRIC* (See below) in which the increment is defined as the total service. Thus, it differs from *LRIC* and marginal cost approaches in that it includes fixed costs that are specific to the service. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Long Run Incremental Costs (LRIC) The incremental costs that arise in the long run with a specific increment in volume of production. LRIC is generally calculated by estimating costs using current technology and best available performance standards. When a cost study is based on the "costs of an efficient firm", it usually refers to LRIC-type methodology. In the presence of joint or common costs, the sum of the LRIC for all of the operator's services will be less than the total costs of the operator. Hence, the operator will not be able to recoup all of its costs. Regulators will generally allow a mark-up to be added to LRIC or LRIC-type costs for the firm to help recover all of its costs. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Main Telephone Line - Telephone line connecting a subscriber to the telephone exchange equipment. This term is synonymous with the terms main station, Direct Exchange Line (DEL) and main access line.

Marginal Cost - The change in total cost resulting from a very small change in the volume of output produced. Due to a number of practical issues, including the lumpiness of capital increments (i.e. the inability of telecommunications plant to be divided into very small parts, or scaled to provide an exact fit with the actual requirements of the network), marginal cost is difficult to estimate. Accordingly, most estimates of marginal cost are based on incremental cost. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Mark-up - A percentage or a fixed monetary amount that is used to take into account joint and common costs, for example, to supplement certain costing methodologies. Cost concepts that do not fully allocate (or distribute) all indirect costs generally require mark-ups. These cost concepts include incremental costing methodologies, including LRIC (and TSLRIC/LRAIC and TELRIC as discussed in detail in the cost methods section below). The mark-up may be uniform or non-uniform. While regulators have generally set uniform mark-ups to promote competition, the application of Ramsey principles suggests that a non-uniform mark-up may be economically efficient. (See Appendix B: The Economics of Telecommunications Prices and Costs)

Market Power – Generally, a telecommunications operator or other firm is considered to have market power when it is able to establish and maintain prices or other key terms and conditions of sales in a market for a non-transitory period, without regard to the market or the actions of competitors, without losing sales to such a degree as to make this behaviour unprofitable. (See also *Dominance*, above and see Module 5.)

Megabit - One million *bits*. **Mbps** - Megabits per second.

Mobile Cellular Service - A communication service in which voice or data is transmitted by radio frequencies. The service area is divided into cells, each served by a transmitter. The cells are connected to a controlling switching exchange, which is connected to the worldwide telephone network.

Modem - Modulator/Demodulator. A conversion device installed in pairs at each end of analogue communications lines. The modem at the transmitting end modulates digital signals received locally from a computer or terminal. The modem at the receiving end demodulates the incoming analogue signal, converts it back to its original digital format and passes it to the destination device.

Multimedia - The presentation of more than one medium, typically images (moving or still), sound and text in an interactive environment. Multimedia requires a significant amount of data transfer and invariably requires computational facilities.

Multiplexer - A device that combines several communications channels onto a single circuit. The channels are combined by paralleling the channels in real time on the single circuit and distributing them in frequency (Frequency Division Multiplexing--FDM) or by time-sharing the channel (Time Division Multiplexing--TDM).

Multiplexing - (1) To combine the signals of two or more channels into one single channel for transmission over the telecommunications network. (2) Division of a transmission facility into two or more channels.

National Regulatory Authority (NRA) – See definition of *Regulator* below.

Network - A public and/or private communications transmission system that provides interconnectivity among a number of local or remote devices (e.g. telephones, exchanges, computers, television sets). The PSTN is operated by local PTOs. Like the PSTN, other private and public networks can comprise many point-to-point transmission media, including wire, cable and radio-based ones.

Network Access Point (NAP) - Point at which dedicated Internet backbone lines are reached or at which ISPs connect with one another. NAPs serve as data interchange points for backbone service providers. NAPs and Metropolitan Area Exchanges (MAEs) are increasingly referred to as public Internet exchange points (IXPs).

Network Redundancy - A telecommunications path that has backups connecting various points in case one path fails (e.g. if a cable is cut).

New Entrant - A new telecommunications service provider, including a new PTO.

Node - A computer, switch or other device when it is considered as part of a network.

Number Portability - The ability of a customer to transfer its service account from one operator to another without requiring a change in the customer's number.

Online Service and Software Companies - Companies which operate Internet sites whose principal function is to provide services in electronic form, including transactions with third parties, sales and support for its products and software which can be downloaded by end users for a fee or without charge.

Open System - A computing system that uses publicly available standards so that it can communicate with other systems using the same standards.

Open Systems Interconnection (OSI) - The overall name for *ISO's* classification of standards for global connectivity. *ISO* has developed a seven-layer model for standards-based networking and is in the

process of developing protocols that comply with this model.

Operating System - Software that provides the link between a computer's application programs and its hardware.

Out-of-Band Signalling - A communications technique used between switches and other telecommunications equipment in which the control signals are exchanged through a control channel that is separate from the channel(s) carrying the information.

Packet - A unit of information identified by a label at layer 3 of the OSI reference model. The term is used to describe a collection of bits that contain both control information and content. Control information is carried in the packet to provide for addressing, sequencing, flow control and error control at each of several protocol levels. A packet can be fixed or variable in length, but generally has a specified maximum length.

Packet Switching - A data telecommunications technique in which information is grouped into packets for ease of handling, routing, supervising and controlling on telecommunications networks. Packets are sent to their destination by the fastest route. The transmission channel is occupied only while the packet is being transmitted and the channel is then available to transfer other packets between other data terminal equipment. Individual packets may reach the destination by different routes and in the wrong order. The destination node is responsible for reassembling the packets into the proper sequence. Packet switching is used in most data networks, including those that use the older X.25 protocol, and the Internet, which uses TCP/IP Protocols.

Paging - A mobile radiocommunication service offering - usually one-way - of numeric or textual information to small pocket terminals.

PCM - Pulse Code Modulation. The technique most frequently used to sample and convert analogue signals to a digital format. In telephony, PCM is used to convert analogue voice signals to an 8-bit digital format at an 8 KHz rate, producing a serial bit stream of 64 kbps.

Peak rate - Term used for calls made during the busy part of the working day, at full tariff. *Off-peak* refers to calls made at other times, often with discounted tariffs.

Peering - The exchange of routing announcements between two Internet Service Providers for the purpose of ensuring that traffic from the first can reach customers of the second, and vice-versa. Peering takes place predominantly at IXPs and usually is offered either without charge or subject to mutually agreed commercial arrangements.

Penetration - A measurement of access to telecommunications, normally calculated by dividing the number of subscribers to a particular service by the population and multiplying by 100. Also referred to as *teledensity* (for fixed-line networks) or *mobile density* (for cellular ones).

Personal Communication Services (PCS) - In the United States and Canada, refers to digital mobile networks using the 1900 Mhz frequency. In other countries, refers to digital mobile networks using the 1800 Mhz frequency (See DCS-1800). The term *Personal Communications Network (PCN)* is also used.

Point of Interconnection (POI) - The physical location at which two networks interconnect.

Point of Presence (PoP) - A Point of Presence is a switch, node or other facility offering users access in a particular market (e.g. dial-up access to the Internet via a specific telephone number). The greater the number of PoPs, the higher the likelihood that users can connect using a local telephone call.

Port - The physical access point to a computer, switch, device, or network where signals may be supplied, extracted or measured.

Portal - Although an evolving concept, the term "portal" commonly refers to the starting point, or a gateway through which users navigate the World Wide Web, gaining access to a wide range of resources and services, such as e-mail, forums, search engines, and shopping malls. A mobile portal implies a starting point, which is accessible from a mobile phone.

Post Telephone and Telegraph Administration (PTT) - Term used to designate government departments or agencies that traditionally owned and operated the PSTN as monopolies mainly in Europe, Asia and Africa.

Post, Telegraph and Telephone Administration (PTT) - The traditional organization of the communication sector in many countries was the PTT (the Post, Telegraph and Telephone Administration) wherein the government owns and operates both telecommunication and postal services.

Predatory Pricing – Anti-competitive practice of providing services at prices that are low enough to drive competitors out of a market, or prevent new entry by them, so as to monopolize the market. (See Module 5.)

Price Cap – Is a rules-based form of price regulation that uses a formula to determine the maximum allowable price increases for a regulated operator's services for a specified year or number of years. The formula typically allows an operator to increase its rates annually for a service or basket of services by an amount equal to inflation, less an amount equal to the assumed rate of productivity increases. Other variables may be taken into account in the price cap formula such as 'exogenous factors' outside of the operator's control and the quality of service provided by the operator. (See Module 4.)

Primary Rate Interface - Also called Primary Rate Access. A term used to designate an integrated services digital network (*ISDN*) interface standard that is designated in North America as having 23B+D channels, in which all circuit-switched B channels operating at 64 kb/s and in which the D channel also operates at 64 kb/s. The PRI combination of channels results in a *digital signal level 1* (or *T1*) interface at the network boundary.

Private Branch Exchange (PBX) - Equipment that is located on a customer's premises that controls and switches information between local terminal equipment, such as telephones or data terminals, and provides access to the PSTN. Sometimes PBXs are referred to as Private Automatic Branch Exchanges (PABXs). (See also *Key Telephone System*.)

Private Network - A network based on leased lines or other facilities which are used to provide telecommunication services within an organization or within a closed user group as a complement or a substitute to the public network.

Private Ownership/Privatization - The transfer of control of ownership of a state enterprise to private parties generally by organizing the enterprise as a share company and selling shares to investors. More generally, the term is sometimes used to refer to a wide range of modalities whereby business is opened to private enterprise and investment.

Proprietary Standard - A standard that is owned or controlled by a single person or legal entity. A proprietary standard can be used for interoperability if the company that controls it is willing to license it and publish its specifications.

Protocol - A set of formal rules and specifications describing how to transmit data, especially across a network or between devices.

Public Switched Telephone Network (PSTN) - The infrastructure of physical switching and transmission facilities that is used to provide the majority of telephone and other telecommunications services to the public. In a monopoly environment, one PTO owns and operates the PSTN. In a competitive environment, the PSTN typically comprises the interconnected networks of two or more PTOs.

Public Telecommunications Operator (PTO) - normally a "facilities-based operator" such as a telephone company, which provides telecommunications services to the public for compensation. The term "public" relates to the consumer rather than the ownership of the PTO. In some countries the terms "telecommunications common carrier", "common carrier" or simply "carrier" are used instead of PTO.

RAG - Radiocommunication Advisory Group of the ITU. (See Module 1 for description of the ITU.)

Rate of Return Regulation (ROR) - Is a rules-based form of price regulation designed to provide the regulated operator with relative certainty that it can meet its revenue requirements and that prices will be adjusted, as required to meet that objective. Under this scheme, the regulated operator's

revenue requirement is calculated and then service prices are adjusted so that its overall service revenues cover such revenue requirement. (See Module 4.)

Rate Rebalancing - It refers to the adjustment of rates charged for different services to more closely reflect their costs. In most countries, this means increasing local access rates and decreasing international, long distance, local usage rates and Internet access. (See Appendix B, Module 4 and Appendices to Module 6.)

Regulator - This term is used to refer to government agency, institution or official responsible for regulation of all or part of the telecommunications sector in a country. In some countries it is a National Regulatory Authority (NRA), an independent regulatory authority, or a Ministry of the Government. Sometimes, one entity is the regulator for some purposes and another entity for other purposes. Different institutional approaches to regulation are discussed in Module 1.

Reseller - A public telecommunications service provider that does not own network transmission facilities but obtains transmission facilities or services from others (usually from a PTO) for resale to its customers. These facilities or services may be resold with other services (e.g. value-added services) or without ("simple resale"). Some resellers operate their own switches, routers and processing equipment. Others do not.

Roaming - A service allowing cellular subscribers to use their handsets on networks of other operators.

Router - Specialized computers that receive transmissions of packets and compare their destination addresses to internal routing tables and, depending on routing policy, send the packets out to the appropriate interface. This process may be repeated many times until the packets reach their intended destination.

Routing Policy - An expression of how an ISP will choose to direct traffic on or off network. For example, ISPs may choose to route traffic with preference to certain paths or through other ISPs depending on the commercial relationships between the parties.

RRB - Radio Regulations Board of the ITU. (See Module 1 for description of the ITU.)

Sender Keep All - Another term for *Bill and Keep*. (See Module 3.)

Server - (1) A host computer on a network that sends stored information in response to requests or queries. (2) The term "server" is also used to refer to the software that makes the process of serving information possible.

Short Message Service (SMS) - A service available on digital networks, typically enabling messages with up to 160 characters to be sent or received via the message centre of a network operator to a subscriber's mobile phone.

Signalling System Number 7 - AN ITU-T common channel signalling protocol providing enhanced control functions such as look-ahead routing for high-speed digital communications services between intelligent network nodes. Signalling information is sent at 64 kbps. Also referred to as Common Channel Signalling System Number 7 (CCSS7), or CCITT Number 7 Signalling.

Significant Market Power – Test set out in several European Directives to identify operators that have greater than a 25% share of a particular telecommunications market and that are required to meet certain obligations (e.g. Article 4 of the *Interconnection Directive* mandates operators with significant market power to "meet all reasonable requests for access to the network, including access at points other than the network termination points offered to the majority of end-users"). (See Module 5.)

Spectrum - The radio frequency spectrum of Hertzian waves used as a transmission medium for cellular radio, radiopaging, satellite communication, over-the-air broadcasting and other wireless services.

Splitter - A device used in a cable system or wire network to divide the power of a single input into two or more outputs of lesser power. It can also be used when two or more inputs are combined into a single output.

SS7 - See *Signalling System Number 7*.

Stand-alone Cost - The total cost to provide a particular product or service in a separate production process (i.e. without benefit of scope economies). (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Standards - Recommendation for the protocol, interface, type of wiring or some other aspect of a network. Recommendations range from a conceptual definition for a general framework or model for communications architecture to specific interfaces. Standards are developed by internationally or nationally recognized bodies such as ITU-T or telecommunications equipment vendors.

Subscriber Identity Module (SIM) Card - A small printed circuit board inserted into a GSM-based mobile phone when signing on as a subscriber. It includes subscriber details, security information and a memory for a personal directory of numbers.

Switch - Telecommunications equipment that establishes and routes communications paths between different lines, trunks or other circuits. Switches establish circuits or paths between different end users or between other devices attached to telecommunications networks. A PBX is a form of switch located on customer premises. The term *Exchange* is generally used to refer to switches that are connected to the *PSTN*.

Synchronization - Timing pulses to maintain the proper identity between the transmitted and received pulses.

T-1 - A North American digital standard referring to any transmission line or connection operating at the DS1 rate of 1.544 Mbps. (See *T-1*.)

T-3 - Refers to transmission at 44.736 Mbps, etc. (See *E-1*)

Telecommunications Facility Provider - An entity that supplies underlying transmission capacity for sale or lease and either uses it to provide services or offers it to others to provide services.

Teledensity - Number of main telephone lines per 100 inhabitants.

Total Cost - The aggregate amount of all costs incurred in producing a specified volume of output. The sum of fixed and variable costs equals total cost. (See Appendix B: The Economics of Telecommunications Prices and Costs).

Transmission Control Protocol/Internet Protocol (TCP/IP) - The suite of protocols that defines the Internet and enables information to be transmitted from one network to another.

TSB - Telecommunication Standardization Bureau of the ITU. (See Module 1 for description of the ITU).

Type Approval - An administrative procedure of technical tests and vetting applied to items of telecommunication equipment before they can be sold or interconnected with the public network. Also known as homologation.

UMTS Terrestrial Radio Access (UTRA) - The European third-generation mobile standard ETSI has agreed on which draws upon both W-CDMA and TDMA-CDMA proposals.

Unbundled Local Loop - Access to the full and exclusive use of the copper pair connected to the customer and/or some form of shared access to the local loop. Full unbundling refers to access to raw copper local loops (copper terminating at the local switch) and subloops (copper terminating at the remote concentrator or equivalent facility). Shared access refers to the non-voice frequencies of a local loop and/or access to space within a main distribution frame (MDF) site of an operator for attachment of DSL access multiplexers (DSLAMS) and similar types of equipment to the local loop of the notified operator.

Unbundling - Refers to the provision of components on a stand-alone basis. Therefore, interconnecting carriers can obtain access to single unbundled component without an obligation to buy other components as part of an "interconnection package" (See Module 3.)

Uniform Resource Locator (URL) - The standard way to give the address or domain name of any Internet site that is part of the World Wide Web (WWW). The URL indicates both the application

protocol and the Internet address, e.g. <http://www.itu.int>.

Universal Access – A term generally used to refer to a situation where every person has a reasonable means of access to a publicly available telephone. Universal Access may be provided through pay telephones, community telephone centres, teleboutiques, community Internet access terminals or similar means. (See also *Universal Service*; see Module 6.)

Universal Mobile Telecommunications System (UMTS) - The European term for third generation mobile cellular systems. For more information, see the UMTS Forum website at <http://www.ums-forum.org>.

Universal Service – Generally refers to a policy focused on promoting or maintaining “universal” availability of connections by individual households to public telecommunications networks. (See also *Universal Access*; see Module 6.)

Universal Service Obligation (USO) – Generally refers to the obligation imposed on a telecommunications operator to meet the policy objective of connecting all, or most, households to public telecommunications networks. The term is often used more generally to refer to operators’ obligations to take initiatives to promote *Universal Access* as well as *Universal Service*. (See Module 6.)

Universality – Term used in this Handbook to refer generally to *Universal Access* and *Universal Service*. (See Module 6.)

Universality Fund / Universal Service Fund - Such funds typically collect revenues from various sources and disburse them in a fairly targeted manner to achieve specific universality objectives. Depending on the country, the source of revenues may include government budgets, charges on interconnecting services or levies on telecommunications services or operators. (See Module 6.)

Value Added Services (VAS) - Telecommunication services provided over public or private networks which, in some way, add *value* to the basic carriage, usually through the application of computerized intelligence, for instance, reservation systems,

bulletin boards, and information services. Also known as value added network services (VANS) and *enhanced* services.

Variable Cost - A cost that varies with increased volume of production. (See Appendix B: The Economics of Telecommunications Prices and Costs.)

Vertical Price Squeezing - Occurs when an operator with market power controls certain services that are a key input for competitors in subordinated or ‘downstream’ markets and where those same key inputs are used by the operator or its affiliates to compete in the same downstream markets. For example, an incumbent telecommunications operator often controls local access and switching services which are key for competitors to compete with the same incumbent operator in a ‘vertical’ market. (See Module 5.)

Very Small Aperture Terminal (VSAT) - A satellite earth station with a small antenna, usually six metres or less. Generally used for point-to-multipoint data networks, they have dramatically lowered the cost of satellite communications.

Virtual Private Network (VPN) - Uses a telecommunications operator’s network to provide the functions of private lines. Users can design, change and manage a private network without having to invest in capital equipment or manage switching equipment and leased lines. Also known as a Software Defined Network.

Voice Mail/Voice Messaging - A technique for sending, storing and handling digitized voice information. Information is stored in “voice mail boxes”, one of which is assigned to each end-user on the system. Owners of voice mail boxes, and callers who access them, interact with the system through a touch-tone telephone key pad. Mailbox owners can retrieve, save, reply to, forward, forward with comments and delete voice messages.

Webcasting - A group of emerging services that use the Internet to deliver content to users in ways that sometimes closely resemble other traditional communication services such as broadcasting.

Website/Webpage - A website (also known as an internet site) generally refers to the entire collection of HTML files that are accessible through a domain name. Within a website, a webpage refers to a single HTML file which, when viewed by a browser on the World Wide Web could be several screen dimensions long. A “home page” is the webpage located at the root of an organization’s URL.

Whole Circuit - A circuit that connects points in different countries where a single entity owns the circuit in its entirety or owns leases, or operates two half-circuits in combination.

Wide Area Network (WAN) – A system of two or more LANs connected over a distance via telephone lines or radio waves.

Wireless Application Protocol (WAP) - A license-free protocol for wireless communication that enables the creation of mobile telephone services and the reading of Internet pages from a mobile terminal, thus being the mobile equivalent of HTTP (Hyper Text Transfer Protocol).

Wireless Local Loop (WLL) - A technique using radio technology to provide the connection from the telephone exchange to the subscriber.

World Wide Web (WWW) - (1) Technically refers to the hypertext servers (HTTP servers) which are the

servers that allow text, graphics and sound files to be mixed together. (2) Loosely refers to all types of resources that can be accessed, including - HTTP, Gopher, FTP, Telnet, USENET and WAIS.

WRC - World Radiocommunication Conference of the ITU. (See Module 1 for description of the ITU.)

WTAC - World Telecommunication Advisory Council of the ITU. (See Module 1 for description of the ITU.)

WTO - World Trade Organization. (See Module 1.)

WTO Regulation Reference Paper - A short paper including a set of principles for the regulation of basic telecommunications services. The paper was included with the commitments of most of the countries that signed the *WTO Agreement on Basic Telecommunications* (ABT). The WTO Regulation Reference Paper is included as Appendix A.

WTSC - World Telecommunication Standardization Conference of the ITU. (See Module 1 for description of the ITU.)

X-Factor – Productivity Factor in *Price Cap* Regulation. (See Module 4.)

3G - Third generation mobile communication system. (See IMT-2000.)

Sources: Various, including ITU, World Telecommunication Development Report, 1999; ITU, Challenge to Network, Internet Development, 1999, McCarthy Tétrault and public domain sources.

APPENDIX D - SELECTED SOURCES

Note: The following list of information sources is selective and not comprehensive. The list has been provided as a starting point for research, not to provide a balanced source of information on all issues. Most of the laws and regulations of ITU Member States are available from the regulatory database of the ITU, at <http://www7.itu.int/treg/>

Module 1 – Approaches to Regulation

Regulatory Documents

ACA (Australian Communications Authority). 1999. *Principles for Decision-Making*. Australia.
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Communication Authority, Hungary. 2000. *Hungarian Telecommunications Regulatory Environment and Authority*, 9th edition. Budapest.
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CRTC (Canadian Radio-television and Telecommunications Commission). 1992. *Introduction of Competition in Public Long Distance Voice Telephone Market*, Telecom Decision CRTC 92-12, 12 June, Ottawa.
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