Application of a TSLRIC Pricing Methodology - Discussion Paper

New Zealand Commerce Commission

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1. Introduction

1. Under the Telecommunications Act (the "Act") the New Zealand Commerce Commission (the "Commission") may apply a total service long-run incremental cost (TSLRIC) pricing methodology when making a determination of the price of certain designated services. These services are interconnection services with fixed Public Switched Telephone Networks (PSTNs).

2. This discussion paper examines the major conceptual and practical issues relevant to implementing a TSLRIC pricing methodology. Where possible, the Commission has indicated its preliminary views on the issues discussed. These views should not be seen as final or pre-judging what the Commission may decide in the event it is required to make a determination concerning interconnection prices. Rather, these views are expressed to provide a focal point for responses to the discussion paper.

3. In addition to this paper, five other papers recently released by the Commission are relevant to understanding the Commission's responsibilities under the Act and the approach the Commission currently proposes to adopt in undertaking these responsibilities. They are:

- *A Guide to the role of the Commerce Commission in making Access Determinations under the Telecommunications Act 2001, a discussion paper*, May 2002, (the "Discussion Paper");
- *Interconnection Pricing Methodology, a paper prepared for the Commerce Commission (New Zealand) by Frontier Economics*, 5 April 2002 (the "Interconnection Methodology Paper");
- *TSO Discussion Paper and Practice Note – Cornerstone Issues Paper*, 22 March 2002 (the "TSO Cornerstone Issues Paper");
- *TSO Discussion Paper and Practice Note – Implementation Issues Paper*, 19 April 2002 (the "TSO Implementation Issues Paper"); and
- *International Benchmarks: Review of Interconnection and Retail-Minus Wholesale Discounts, Prepared for the Commerce Commission (New Zealand) by CostQuest Associates,* 5 April 2002.

4. These papers are available on the Commission's website.

5. The Commission seeks written comments on this paper and intends to hold an industry conference in the near future where parties can express their views directly to the Commission.

2. Background

6. Before examining the TSLRIC pricing methodology and how it should be implemented, it is important to clarify the services to which it may be applied and the objectives and definitions under the Act relevant to its implementation. The aim is to develop a common understanding of the objectives of the Commission in making determinations of interconnection prices and the principles that will guide the Commission in implementing the TSLRIC pricing methodology.

2.1. Legislative requirements

7. Under the Act, the Commission may be required to make a determination concerning the prices of designated services. In making such a determination the Commission must:

- have regard to the purpose of the Act;
- make the determination in accordance with any applicable pricing principles; and
- consider other matters as specified in the Act.

2.1.1. Designated interconnection services

8. The Commission may determine prices on the basis of a TSLRIC pricing methodology for the following services:

9. *Interconnection with Telecom's fixed PSTN* - Origination and termination (and their associated functions) of voice and data calls (including dial-up internet calls) on Telecom's fixed PSTN. This service is designated where any service provider is the access seeker.

10. *Interconnection with fixed PSTNs other than Telecom's* - Origination and termination (and their associated functions) of voice and data calls (including dial-up internet calls) on a fixed PSTN other than Telecom's. This service is designated where Telecom is the access seeker.

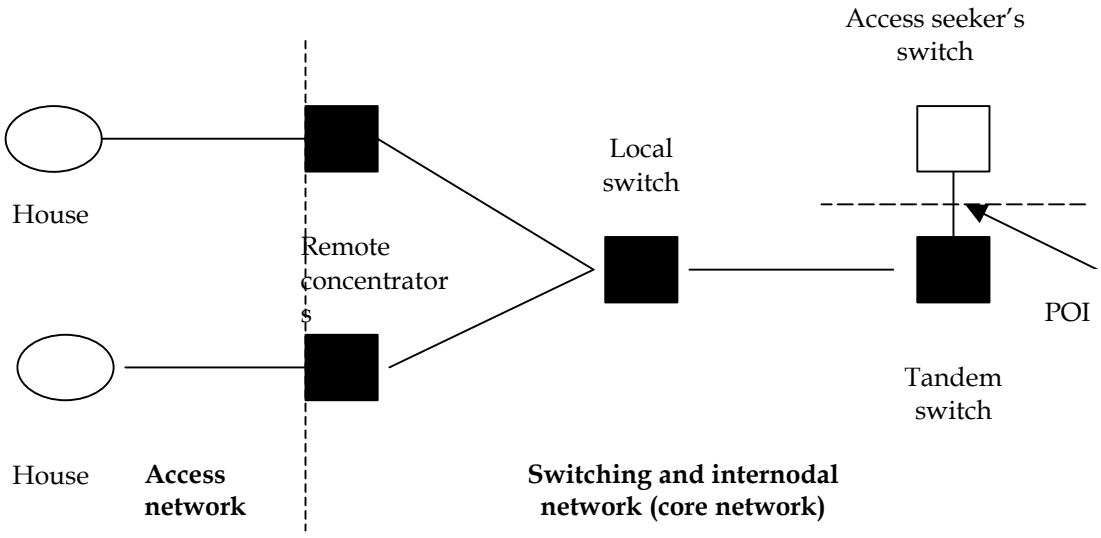
Types of interconnection services

11. The designated services capture four major types of interconnection services:

- local interconnection;
- toll bypass interconnection;
- interconnection for toll free calls; and

- mobile to fixed interconnection.

Figure 1: Originating and terminating access services (interconnection services)



12. Interconnection services involve either call origination and/or call termination. Local interconnection is interconnection between two fixed PSTNs for the purposes of **terminating** local calls. Toll bypass interconnection is interconnection between a toll bypass operator and one or more fixed PSTNs for the purposes of **originating and/or terminating** national and international toll calls. Interconnection for toll-free calls is interconnection between two fixed PSTNs for the purpose of **originating** toll-free calls. Mobile to fixed interconnection is interconnection between a mobile network and a fixed PSTN for the purposes of **terminating** calls from mobile to fixed-line phones. Each of these types of interconnection is described further in the *Interconnection Methodology Paper*.

How interconnection services are provided

13. Call origination services involve the carriage of a call by the access provider from the party making the call (the A-party) to a point of interconnection (POI) or point of handover to the access seeker. Call termination services involve the carriage of calls by the access provider from a POI to the party receiving the call (the B-party). These are illustrated in Figure 1. Figure 1 also depicts the access provider's fixed PSTN that carries calls between users and the point of handover to the access seeker. In the simplified case depicted in Figure 1, call origination will involve the carriage of the call from the user to a POI located at second level or tandem switch. This is likely to be the case for call origination for toll bypass calls for instance. Call termination involves the carriage of the call from the POI to the user. It

should be noted that the POI is not necessarily located at the tandem switch or that interconnection services necessarily involve the use of both of these network elements. In some cases the POI may be located at the local switch. This is often the case for local interconnection services for instance. Further, the network may be configured to direct calls from users directly to a local switch, in which case a remote concentrator is not used.

It should be noted that Figure 1 shows the boundary of the core switching network to be the customer facing edge of remote concentrator units. While this is often true in today's network configuration, a forward looking network design may replace some smaller remote concentrators or switches with customer access transmission units, thereby reducing the overall number of switching nodes. This issue is discussed further in Section 3.1.2.

2.1.2. Applicable pricing principles

14. If the Commission is required to determine prices for interconnection services, the Act specifies that the determination must be made in accordance with any applicable pricing principles. Initial pricing principles apply to any initial determination made by the Commission. Final pricing principles apply if the Commission is required to review that determination. Under the final pricing principles, the Commission must determine a price in accordance with:

> (a) TSLRIC; or
>
> (b) if the Commission considers that TSLRIC does not best give effect to the purpose set out in section 18, whichever of the following methods that the Commission considers best gives effect to that purpose:
>
> (i) a pure bill and keep method; or
>
> (ii) a pure bill and keep method applied to two-way traffic in balance (or to a specified margin of out-of-balance traffic) and TSLRIC applied to out-of-balance traffic (or traffic beyond a specified out-of-balance margin).

15. The Commission is of the preliminary view (see the *Interconnection Methodology Paper*) that the TSLRIC pricing methodology should be used to determine prices for toll bypass, toll free and mobile to fixed interconnection services. It is the Commission's preliminary view that bill and keep or a hybrid of bill and keep and TSLRIC should be used to determine prices for local interconnection services.

16. Although the Commission may be required to determine prices for interconnection with Telecom's fixed PSTN and interconnection with other fixed PSTNs, most of the discussion in this paper focuses on the former. How

charges for interconnection with other fixed PSTNs should be determined are discussed in chapter 12.

2.1.3. Purpose of the Act

17. If the Commission is required to make a determination concerning the price of a designated service (such as the interconnection services), it must make a determination that it considers best gives, or is likely to best give, effect to the purpose set out in Section 18 of the Act.

18. Section 18 of the Act states:

> (1) The purpose of this Part and Schedules 1 to 3 is to promote competition in telecommunications markets for the long-term benefit of end-users of telecommunications services within New Zealand by regulating, and providing for the regulation of, the supply of certain telecommunications services between service providers.
>
> (2) In determining whether or not, or the extent to which, any act or omission will result, or will be likely to result, in competition in telecommunications markets for the long-term benefit of end-users of telecommunications services within New Zealand, the efficiencies that will result, or will be likely to result, from that act or omission must be considered.

2.1.4. Other matters specified in the Act

19. In applying the pricing principles, the Commission must consider a number of other matters. Specifically:

(a) incentives to terminate dial-up internet traffic and other similar one-way traffic streams must be efficient; and

(b) the effect of any obligation under the TSO instrument to provide price-capped unlimited calls.

2.2. Interconnection prices and the purpose of the Act

20. The Commission has described its interpretation of the purpose of the Act in the *Discussion Paper*. In considering whether a determination will result, or will be likely to result, in competition in telecommunications markets for the long-term benefit of end-users, the Commission will consider the effects of the determination on three types of economic efficiency, allocative efficiency, productive efficiency and dynamic efficiency, while giving priority to the latter.

21. The Commission will endeavour to set interconnection prices to encourage parties to make efficient decisions (or as efficient decisions as possible given other constraints). Some of the decisions affected by interconnection prices are discussed below.

22. *Decisions of access providers to invest in fixed PSTNs* — In order to promote efficient investment, interconnection prices should be set to ensure that access providers have the expectation of recovering the costs of prudent investment. That is, at the time of making prudent investments in network infrastructure, access providers should have the expectation that future interconnection revenues will be sufficient to recover the costs of those investments. These future revenues will depend on the interconnection prices set by the Commission.

23. *Decisions of access providers to provide interconnection services in the most cost effective manner* — The incentives for access providers to provide interconnection services in the most cost effective manner are driven by the relationship between their costs and their profits. If profits of access providers are largely unaffected by the costs they incur in providing interconnection services, then their incentives to minimise those costs will be weak. To the extent possible, the cost base upon which interconnection prices are set should be 'decoupled' from the access provider's actual costs.

24. *Decisions of access seekers (or other investors) to duplicate parts or all of an access provider's fixed PSTN* — Potentially, interconnection prices can affect the decisions of access seekers or other investors to build their own fixed PSTN in order to bypass all or part of the access provider's fixed PSTN. Interconnection prices should be set to neither encourage inefficient duplication nor discourage efficient duplication. In practice this is a difficult task.

25. *Decisions of providers to enter and exit telecommunications markets* — Interconnection is often a necessary service for entry and competition in dependent telecommunications markets. The prices of interconnection services will affect the state of competition in telecommunications markets dependent on those services. To the extent possible, interconnection prices should be set to encourage efficient entry and exit decisions and to enable more efficient providers to attract and retain customers from less efficient providers.

In determining interconnection prices on the basis of TSLRIC, the Commission will, among other matters, consider the effect interconnection prices may have on:

- the decisions of access providers to invest in fixed PSTNs;
- the decisions of access providers to provide interconnection services in the most cost effective manner;
- the decisions of access seekers (or other investors) to duplicate parts or all of the access provider's fixed PSTN;
- and decisions to enter and exit dependent telecommunications markets.

3. TSLRIC

26. Under the Act, TSLRIC, in relation to a telecommunications service,

> (a) means the forward-looking costs over the long run of the total quantity of the facilities and functions that are directly attributable to, or reasonably identifiable as incremental to, the service, taking into account the service provider's provision of other telecommunications services; and
>
> (b) includes a reasonable allocation of forward-looking common costs.

where forward-looking common costs,

> (a) means those costs efficiently incurred by the service provider in providing the service that are not directly attributable to providing an additional unit to that service; but
>
> (b) does not include any costs incurred by the service provider in relation to a TSO instrument.

27. The concept of TSLRIC can be more fully described by examining each of its components.

28. **Total service** refers to the total quantity or amount of the service provided by the firm (including the quantity the firm provides for its own use (if any)). As a result, TSLRIC should be distinguished from the incremental (or marginal) cost of the last unit of the service provided by the firm or the incremental cost of providing the amount of the service provided to one particular customer.

29. **Long run** refers to a period over time in which all resources are variable. That is a period of time sufficient for the firm to be able to alter all the inputs it uses to provide the service. In this way, long run costs include the costs of all the inputs used to provide the service. Importantly, TSLRIC includes costs that once incurred are sunk. For instance, the costs of assets that have no alternative use once deployed.

30. **Incremental cost** refers to the additional costs the firm incurs or will incur in providing the service. Identifying these costs involves a comparison of the costs the firm would incur if it **did** provide the service with the costs the firm would incur if it **did not** provide the service. It is important in this comparison that all other production activities of the firm remain unchanged. For instance, if a telecommunications operator provides telephony and Pay-TV services, the incremental cost of providing telephony services are the additional costs given it already provides Pay-TV services. This distinguishes incremental cost from stand-alone cost. Stand-alone cost refers to the costs incurred by the firm in providing telephony services assuming it does not provide Pay-TV services.

31. TSLRIC, as defined under the Act, 'includes a reasonable allocation of forward-looking common costs'. Common costs are costs incurred in the provision of some or all of the services provided by the firm, but are not attributable to any one service. For example, the costs of a trench that contains fixed PSTN and leased-line cables are common to interconnection services and leased-line services. Most of the costs of the trench are incurred if either service is provided and are not avoided in the long run if the access provider ceases to provide either one of them. It should be noted that common costs only relate to the costs that cannot be directly attributed to one service or another. So for example, if a larger trench is required to add leased-line cables to the trench, the difference between the costs of the larger trench and the smaller trench are directly attributable to leased lines. They do not form part of the common costs of the trench.

3.1. Forward-looking costs

32. Forward-looking costs are costs that will be incurred in the future in providing the service. This involves estimating costs on the basis of current and future prices of inputs and given the availability of modern technologies and assets. The aim is to estimate the cost of providing the services in the future rather than the past.

3.1.1. Forward-looking costs and efficient costs

33. Typically, forward-looking costs and efficiently incurred costs are used synonymously. In the context of forward-looking common costs, the Act refers to "costs efficiently incurred by the service provider". Similar the "net cost" of complying with a TSO instrument means "the unavoidable net incremental costs to an **efficient service provider**" (emphasis added). The Commission takes the preliminary view that forward-looking costs are efficient costs.

34. As noted by Australian Competition and Consumer Commission (ACCC):

> TSLRIC is based on forward-looking costs. These are the ongoing costs of providing the service in the future using the most efficient means possible and commercially available. In practice this often means basing costs on the best-in-use technology and production practices and valuing inputs using current prices.[1]

35. The Federal Communications Commission (FCC) in the US notes:

[1] ACCC, *Access Pricing Principles Telecommunications – a guide*, July 1997, p. 29.

> ….forward-looking economic cost best approximates the costs that would be incurred by an efficient carrier in the market.[2]

3.1.2. Estimating efficient costs in practice

36. Estimating the efficient costs of an access provider is difficult. There are a number of issues to consider, including the:

- location of network nodes; and
- network technology and network assets used to provide the service.

Scorched earth versus scorched node

37. The Commission notes that the scorched node approach is favoured in other jurisdictions, including Australia, the U.S., the UK, Netherlands and Ireland [3]. For example, OFTEL, in building a long run incremental cost model of British Telecom's (BT's) network:

> ….assumed that the number and locations of nodes in BT's network are taken as given (the 'scorched node' assumption).[4]

38. The *TSO Cornerstone Issues Paper* (paras. 158-166) discusses the relative merits of a scorched node or scorched earth approach to determining network costs. The Paper concludes that a scorched node approach is likely to provide the best outcome and be most consistent with the purpose of the Act. Consistent with its approach to estimating the cost of the TSO, the Commission proposes to adopt the basis of a scorched node approach when implementing TSLRIC pricing.

It is the Commission's preliminary view that forward-looking costs should be based on a scorched node assumption of network design, where the locations of core network nodes are taken as given. However, the application of new technology in a forward-looking network design may indicate (for example) the replacement of small remote concentrators or switches with customer access transmission systems. It is therefore possible that the equipment at

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[2] FCC Need reference from the TSO Implementation Paper.

[3] See OPTA/99/8000 *Determination of the Preliminary Tariffs for Interconnection and Special Access that are to be Applied to KPN Telecom B.V. from 1 July 1999 until 1 July 2000*, Holland November 1999 p.32 and ODTR "*The Development of Long Run Incremental Costing for Interconnection Decision Notice D6/99 & Report on Consultation Paper ODTR 99/17*", Ireland June 1999.

[4] OFTEL, *Long Run Incremental Costs: The Bottom-Up Network Model, Version 2.2*, March 1997, p.4.

some network nodes would change in a forward-looking view, affecting whether the element is included in the TSLRIC calculation.

Network technology and network assets

39. Given the location of network nodes, the second question is what network technology and assets to employ to provide the services. This should be based on best-in-use technology. That is the technology employed by an efficient provider given the location of the network nodes and the access provider's current network design.[5] The assets used in the network need not be those currently used by the access provider. Rather they should be based on modern equivalent assets (MEA) at least capable of providing the required level and quality of service.

It is the Commission's preliminary view that forward-looking costs should reflect the costs of providing services using best-in-use technology with modern equivalent assets.

3.2. Reasonable allocation of common costs

40. The Act requires that TSLRIC should include 'a reasonable allocation of forward-looking common costs', where forward-looking common costs,

> (a) means those costs efficiently incurred by the service provider in providing the service that are not directly attributable to providing an additional unit to that service; but
>
> (b) does not include any costs incurred by the service provider in relation to a TSO instrument.

Implications of not including costs incurred in providing TSO services

41. It is the Commission's preliminary view that the purpose of not including 'any costs incurred by the service provider in relation to a TSO instrument' is to prevent 'double recovery' of the net cost of the TSO instrument. That is to avoid (some) service providers paying Telecom for the net cost of the TSO twice, once as payments as liable persons and again through interconnection charges.

42. Currently there is one TSO instrument[6]. This obliges Telecom to provide a range of services (TSO services), including local calls to residential

[5] It is possible that the optimal network technology will differ depending on the location of the nodes. To be clear, under a scorched node approach, the network technology is that employed by an efficient provider given the location of the network nodes.

[6] *Telecommunications Service Obligations (TSO) Deed for Local Residential Telephone Service* between the Crown and TCNZ and TNZL, December 2001

customers. The TSO regime compensates Telecom for the net cost of providing TSO services to commercially non-viable customers (CNVCs).

43. In the case where an exchange area is non-viable, the net loss will be recovered via the TSO provisions. To avoid "double counting", these costs, including those related to the provision of interconnection services (and associated traffic volumes) should be excluded from the TSLRIC calculations. Any revenue received via interconnection payments for these exchange areas, will be treated as revenue when calculating the TSO net loss for the non-viable exchange area.

Costs of providing service to Viable Exchange Areas

44. While, the access network and those parts of the core network used for interconnection are by definition separate (refer back to Figure 1 in Chapter 2), they do share some common costs. For viable exchange areas those costs that are common to both services will be apportioned using the allocation rules described in Chapter 5.

45. This apportionment will ensure that there should be no 'double recovery' of the net cost of the TSO via interconnection charges for CNVCs located in viable exchange areas.

46. By definition the costs of providing commercially viable customers with access to the network are recovered from other revenues achieved by Telecom from providing these customers with access to the network.

It is the Commission's preliminary view that TSLRIC in relation to interconnection services provided by Telecom should not include:

- any net losses for non-viable exchange areas recovered via the TSO provisions; and
- any costs attributable to the access network.

4. Top-down and bottom-up approaches to estimating TSLRIC

47. There are two common approaches to estimating the TSLRIC of providing interconnection services, bottom-up and top-down.

4.1. Bottom-up approach to estimating TSLRIC

48. The bottom-up approach is widely-used by regulators in a number of jurisdictions, including the U.S., Australia, the U.K., Netherlands and Ireland.

49. Bottom-up approaches are constructed from 'the network up'. A network capable of servicing the demand for services is designed and dimensioned. The costs of this network (including operations and maintenance costs and non-network costs) are estimated and allocated across all services (including interconnection services). Typically this involves the following steps:

Step 1: Identify the services to be modelled (e.g. all fixed PSTN services).

Step 2: Determine a network design and network dimensions capable of providing the services (e.g. determine how many lines, switches, etc. and their capacity).

Step 3: Estimate the costs of each network element.

Step 4: Estimate mark-ups on these network costs for network operations and maintenance costs and non-network costs.

Step 5: Calculate a usage based cost (e.g. per minute of use) for each network element based on the costs identified in Steps 3 and 4.

Step 6: Calculate a charge for the interconnection service based on its use of each of the network elements.

50. Bottom-up models are flexible. They can incorporate differing assumptions concerning the technology employed, the network dimensioning rules, the prices of equipment, the rates of depreciation of assets and so on. It should be recognised that the flexibility built into bottom-up approaches can under-estimate the cost efficiency gains available to operators. Given the long-term and sunk nature of telecommunications infrastructure it is not possible for any provider to operate an optimal network at every point of time. Efficient investment at any point of time takes into account and is partly determined by past decisions on network technology and network topology.

4.2. Top-down approach to estimating TSLRIC

51. The top-down approach has gained somewhat less favour among regulators. Where such an approach has been adopted (such as Australia, and the U.K.), it often has been used as a 'rationality' check on the estimates from a bottom-up model. In 1999, the Dutch regulator concluded that an existing top-down model was "insufficient" for the market's requirements and that a change should be made to a bottom-up long term incremental cost model [7].

52. Top-down approaches are based on the firm's current actual costs and capital equipment as detailed in its financial accounts and asset register (although it is possible to adjust these costs to more accurately reflect forward-looking costs). These costs and assets are allocated to services provided by the firm in accordance with allocation rules and processes. Often these allocation rules are formalised in record keeping rules (RKR) agreed with a regulator. RKRs are most often based on fully distributed costs (FDC) where costs are allocated across all the services provided by the firm (including interconnection services). A top-down approach typically involves the following steps:

Step 1: Identify and separate all the services provided by the firm (e.g. local calls, interconnection services).

Step 2: Identify and separate all the costs incurred by the firm and the firm's assets (e.g. personnel costs, copper cable).

Step 3: Identify cost items and assets that are solely attributable to a particular service and allocate the cost item/asset accordingly (e.g. costs of physically interconnecting networks to the interconnection service).

Step 4: Identify the services that contribute to each of the remaining cost items and assets. These costs are common to the services. Allocate the cost items and assets over these services in accordance with allocation rules. This may involve a multi-step process. For instance, network costs and assets may be allocated first. This may be followed by an allocation of non-network costs based on each service's share of network costs.

Step 5: TSLRIC (including an allocation of common costs) for a particular service (such as the interconnection service) is the sum of the costs and a return on assets (identified in Step 3) and the common costs and a return on common assets allocated to the interconnection service (identified in Step 4).

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[7] OPTA/IBT/99/8393 "*Decisions on Tariffs for Interconnection and Special Access Services Applied by KPN Telecom BV in the period 1 July 1998 – I July 1999*". p 7. December 1999

4.3. Assessment of the approaches

4.3.1. Consistency with the Act

53. The primary and over-arching criteria upon which to assess the relative merits of a top-down or a bottom-up approach is their capability to provide an estimate of TSLRIC that is consistent with the definition under the Act. A number of elements of the definition of TSLRIC under the Act are relevant.

Forward-looking costs

54. As noted above, forward-looking costs are the costs that will be incurred in the future in providing interconnection services. Conceptually, a bottom-up approach is more amenable to estimating forward-looking costs than a top-down approach. A top-down approach captures the current costs incurred by the firm in providing the service or the costs incurred in the past. These costs may differ from forward-looking costs in a number of ways.

55. First are differences in the prices of capital equipment and other inputs. Changes in these prices will affect costs over time in at least two ways. First by altering the costs of particular inputs. For example, an increase in wage rates will affect the cost of employing staff. Second by altering the mix of inputs used by the firm. For example, if wage rates increase significantly, the firm may reduce its work force in preference for labour-saving capital equipment.

56. Second are differences in technology. The network technology used by the firm to provide interconnection services evolves over time. As more efficient technology becomes available existing technology may be replaced. As a result, the network technology mix currently used by the firm to provide interconnection services is unlikely to be the same as that used in the future.

57. Third are differences in assets. Network assets also evolve over time. Forward-looking costs are based on the costs using modern equivalent assets. These costs are likely to differ from those using existing assets.

58. Fourth are changes in demand. Given the economies of scale in telecommunications networks, the average cost of providing interconnection services is likely to fall as demand grows. As a result, if demand is growing or shrinking, the current unit costs incurred in providing the interconnection service are unlikely to reflect the costs that will be incurred in the future.

59. The degree to which a top-down cost model will reflect forward-looking costs will depend on two factors. First is the degree to which these and other circumstances are likely to alter the costs of providing interconnection services over time. Second is the ability of the Commission to adjust top-down costs to take account of these and other differences.

60. Although it is possible to adjust top-down costs to better reflect forward-looking costs, it is likely to be more accurate to estimate forward-looking costs directly using a bottom-up approach, as the later approach is based on identifying the costs of modern technology. Section 6.2.1 of the *TSO Cornerstone Issues Paper* discusses the relative accuracy of the two approaches in detail.

Efficient costs

61. The efficiency of the current network will impact on the expected accuracy of the modelling, particularly for the top-down approach. . Being based on actual costs, the costs captured under a top-down approach will reflect any inefficiencies in the access provider's network or its operations.

62. The size of the likely error in practice will depend on two factors, namely the degree to which the access provider's actual costs are costs efficiently incurred and second is the ability to adjust top-down costs to take account of any such inefficiencies. The difficulties required to adjust for this are addressed in Section 6.2.1 of the *TSO Cornerstone Issues Paper*. A more accurate and transparent approach is to estimate efficient network and operational costs directly using a bottom-up model.

63. As noted above the flexibility provided under a bottom-up approach creates the risk of under-estimating efficient costs.

The primary and over-arching criterion upon which to assess the merits of employing a top-down or bottom-up approach is the scope for each approach to generate estimates consistent with the definition of TSLRIC under the Act.

It is the Commission's preliminary view that the flexibility provided under a bottom-up approach and the fact that it is not based on actual costs provides it with an advantage in estimating TSLRIC as defined under the Act. A bottom-up approach, appropriately implemented, is likely to result in more accurate estimates of the TSLRIC than a top-down approach. The Commission is aware that a bottom-up approach has some potential risks.

4.3.2. Other criteria

64. Although the primary criterion upon which to assess the relative merits of a top-down or a bottom-up approach is its capability to provide an estimate of TSLRIC consistent with the Act, other criteria are also relevant. These criteria are address in detail in Section 6.2.2 through to 6.2.5 of the *TSO Cornerstone Issues Paper*.

Transparency

65. Top-down approaches can lack transparency due to problems inherent in their being based on a firm's actual costs such as a reluctance by the firm to

allow scrutiny of those costs and having assumptions embedded in the cost reporting methodologies of the firm.

66. In contrast, most aspects of a bottom-up model are likely to be able to be made available to parties to a dispute. More importantly, many of the assumptions and inputs to a bottom-up model are easily altered. This allows the model to be altered and the importance of particular assumptions and inputs to be determined.

Control

67. It is important in the context of a dispute that no one party unnecessarily has greater control over the evidence that will form the basis of the Commission's determination.

68. Under a top-down approach, there is the possible concern that one party will have an undesirable degree of control over the information. If a bottom-up approach is used, the information required from the access provider is of a different nature (e.g. the volume of telecommunications services provided using the network and the locations of network nodes and points of interconnection).

Time and effort

69. Constructing top-down and bottom-up models to estimate TSLRIC typically involve lengthy and resource-intensive processes. The greater the detail provided in the model the longer and more resource-intensive the process. For instance, a model that disaggregates costs by geographic area (which is necessary to enable geographic pricing) will inevitably extend the process and be more costly.

70. The ability to construct a reasonable estimate of TSLRIC in a timely fashion using a top-down approach will depend on how costs are recorded and allocated to particular services in the access provider's accounts. If the costs are recorded and allocated in a manner, which does not allow the cost elements of TSLRIC (as defined under the Act) to be identified and measured, then an accounting separation framework must be developed. This is likely to be a time-consuming process.

Consistency with other telecommunications determinations

71. As noted in Section 6.2.6 of the *TSO Cornerstone Issues Paper*, there are benefits in using the same or similar approaches for TSO and interconnection determinations. Benefits include synergies in the modelling effort and consistency in how costs are measured (e.g. to reduce any gaps or overlap).

On the evidence available, a bottom-up approach, appropriately implemented:

- is more likely to provide an estimate that is consistent with the definition of TSLRIC under the Act; and
- will allow for consistency between the Commission's decision on the net cost of the TSO and interconnection prices.

The Commission seeks comments on the relative merits of estimating TSLRIC using a top-down or bottom-up model.

5. Estimating TSLRIC using a bottom-up approach

72. TSLRIC in relation to a telecommunications service comprises four types of costs:

- *Network capital costs* – Capital costs of network equipment or elements used to provide the service (such as the cost of switches).
- *Network operating and maintenance (O&M) costs* – Costs of operating and maintaining the network used to provide the service (such as the cost of maintaining switches).
- *Non-network capital costs* – Capital costs of equipment required to support the network (such as office accommodation for accounting and finance, human resource management and general administration services).
- *Non-network O&M costs* – Non-capital costs of network support services (such the costs of labour and materials for accounting and finance, human resource management and general administration services).

5.1. Element-based approach to estimating TSLRIC

73. It is common practice among regulators and cost modellers to estimate TSLRIC using an element-based approach. An element-based approach involves the following tasks.

74. ***Task 1: Develop a network*** by determining the quantity and dimensions of the network elements necessary to provide the services. For example, it involves determining the number of switches by type, the kilometres of optical fibre by type, the kilometres of trenches and so on

75. Three key issues need to be resolved in developing the network model. One is to determine the type and quantity of services provided by the network. The second is to determine the technology (and hence types of network equipment) used to provide the services. The third is to determine the dimensions of the network equipment to provide the services. Each of these are discussed in this Chapter.

76. ***Task 2: Determine the costs of the network elements.*** This involves determining:

- the (asset) values of the network equipment (Chapter 6);
- depreciation expenses in relation to the assets (Chapter 7); and
- the costs of the funds invested in the assets (return on funds) (Chapter 8).

77. ***Task 3: Determine network operating and maintenance costs***, which are typically estimated as percentages of the capital costs of network elements (Chapter 9).

78. ***Task 4: Determine non-network costs***, which are typically, estimated as percentages of network capital and network operating and maintenance costs (Chapter 10).

79. ***Task 5: Determine usage costs per network element*** by dividing the sum of these costs by the use of the elements (either calls or call minutes).

80. ***Task 6: Determine per minute interconnection costs*** as the sum of the per minute usage costs of the network elements used to provide interconnection services.

An example

81. An example on how this gets put together may assist. Consider an interconnect call to or from a POI located at a tandem switch. This is illustrated in Figure 2 below.[8] Assume that the interconnect call requires the use five network elements:

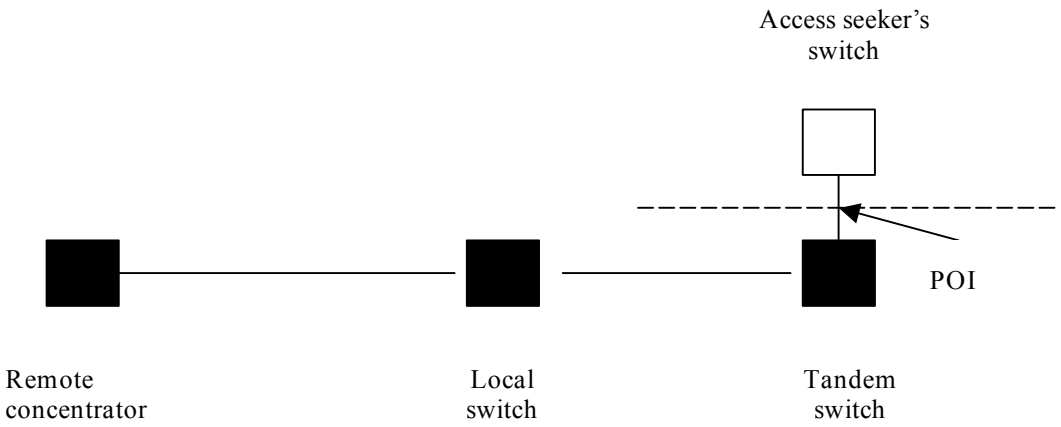
- a remote concentrator;
- a link between the remote concentrator and a local switch;
- a local switch;
- a link between the local switch and a tandem switch; and
- a tandem switch.[9]

82. The interconnect call can be **either** originating access where the call is transported from the A-party to the remote concentrator through the local switch to the tandem switch and the POI, **or** terminating access where the call is transported from the POI to the tandem switch, through the local switch to the remote concentrator and then onto the B-party.

Figure 2: Core network elements used to provide interconnection services

[8] It should be noted that this one of a number of possible configurations of a fixed PSTN. For instance, in other cases the remote concentrator is co-located with the local switch.

[9] It should be noted the costs of an interconnect call are those to and from the POI and hence do not include the access seeker's switch.



83. Assume the network and non-network capital and O&M costs attributed to **each** network element are as detailed in Table 1. These costs and the interconnection prices derived below are for the purposes of demonstration only. As shown in the table, the total annual costs of each network element are 'built up' from their asset values. The steps are as follows:

- Asset values of each of the network elements are determined *(row 1)*;
- Network asset values are converted into annual costs of depreciation and return on funds invested *(row 2)*;
- Network O&M costs are estimated as percentages of network capital costs (by network element) *(row 3)*;
- Non-network asset values are estimated as a percentage of network asset values *(row 5)*;
- Non-network asset values are converted into annual costs of depreciation and return on funds invested *(row 6)*;
- Non-network O&M costs are estimated as a percentage of network O&M costs (by network element) *(row 7)*;
- Annual costs for each network element are totalled *(row 9)*;

Table 1: Example of element based approach to determining interconnection charges

	Remote concentrator	Link b/w remote and local	Local switch	Link b/w local and tandem	Tandem switch
Network asset value ($'000)	200	100	2,000	600	4,000
Annual network capital cost ($'000) *(% of network asset values (incl. dep'n and return on funds))*	60 *(30%)*	20 *(20%)*	500 *(25%)*	120 *(20%)*	1,000 *(25%)*
Network O&M costs ($'000) *(% of network asset values)*	10 *(5%)*	10 *(10%)*	100 *(5%)*	60 *(10%)*	200 *(5%)*
Annual network costs ($'000))	**70**	**30**	**600**	**180**	**1,200**
Non-network asset values ('000) *(% of network asset values)*	10 *(5%)*	5 *(5%)*	100 *(5%)*	30 *(5%)*	200 *(5%)*
Annual non-network capital costs ($'000) *(% of non-network asset values (incl. dep'n and return on funds))*	2.5 *(25%)*	1.25 *(25%)*	25 *(25%)*	7.5 *(25%)*	50 *(25%)*
Non-network O&M costs ($'000) *(% of network O&M costs)*	2.5 *(25%)*	2.5 *(25%)*	25 *(25%)*	15 *(25%)*	50 *(25%)*
Annual non-network costs ($'000))	**5**	**3.75**	**50**	**22.5**	**100**
Total annual costs ($'000)	**75**	**33.75**	**650**	**202.5**	**1,300**
Annual minutes of traffic using the network element (million)	4.69	4.69	162.5	40.5	2,600
Cost per minute of traffic (cents per min.)	**1.6**	**0.72**	**0.4**	**0.5**	**0.05**

- Total annual traffic using the network element (including interconnection traffic) are calculated[10] *(row 10)*;

- Cost per minute of traffic for each network element is computed *(row 11)*.

84. As an interconnect call from a POI at the tandem switch uses each of the five network elements once[11], the per minute cost of the interconnect call is (1.6 + 0.72 + 0.4 + 0.5 + 0.05) which equals 3.27 cents per minute.

85. If, on the other hand, the POI is located at the local switch it will only use three network elements once (the remote concentrator, the link between the remote concentrator and the local switch and the local switch) and the per minute cost of the interconnect call is (1.6 + 0.72 + 0.4) which equals 2.72 cents per minute.

5.1.1. Consistency with the definition of TSLRIC under the Act

86. One issue that arises with the element-based approach is whether it will produce interconnection charges that are consistent with the definition of TSLRIC under the Act. Under the Act, the TSLRIC in relation to interconnection services consists of:

- forward-looking costs directly attributable to, or reasonably identifiable as incremental to, the interconnection service, taking into account the service provider's provision of other telecommunications services; and

- a reasonable allocation of forward-looking common costs.

87. As shown in Table 1, under the element-based approach, costs are allocated to particular services via a two-step method to calculate the cost of providing those services. First, network and non-network costs are allocated to individual network elements. Second, the costs allocated to each network element are allocated to services on the basis of the usage of the network element.

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[10] Total annual traffic using the network element is the total minutes of usage of the element by all call types. An interconnect call (which is either originating access or terminating access) will use each of the network elements once. A local call may use some of the elements twice (once at each end of the call). If a local call uses say the remote concentrator twice and the local call lasts 10 minutes, the total minutes for which the local call uses the remote concentrator is 20 minutes.

[11] This assumes that the call is successful.

Directly attributable or incremental costs of providing interconnection services

88. Directly attributable or incremental costs of providing interconnection services are costs that, over the long run, would not be incurred if interconnection services were no longer provided. This consists of network equipment solely dedicated to providing interconnection services, plus the costs of shared network equipment that would be avoided in the long run if interconnection services were no longer provided (such as the cost savings from smaller switches and transmission equipment). These costs are of three types:

- the costs incurred in physically interconnecting the networks;
- network costs directly attributable or incremental to providing interconnection services; and
- non-network costs directly attributable or incremental to providing interconnection services (such as billing for interconnection services).

Cost of physically interconnecting networks

89. The costs incurred in physically interconnecting networks include the costs of connecting the links between the access provider's and access seeker's switches. These costs should be separately estimated and fully allocated to interconnection services. Under the interconnection agreements commencing in August 2000 and October 2000 between Telecom and TelstraSaturn and Telecom and Clear Communications, respectively, these services are charged separately from the services of originating and terminating calls.

Network costs

90. Network costs (including both capital and O&M costs) directly attributable or incremental to providing interconnection services are predominately traffic-sensitive costs.[12] That is they vary with the amount of (interconnection) traffic. They include the costs of dimensioning larger switches and transmission links to cater for interconnection traffic during the busy hour. Although switches and transmission links are shared with other services (such as local calls for instance), an identifiable component of their capacity is attributable or incremental to interconnection services.

[12] There are potentially two ways in which costs directly attributable or incremental to interconnection services could be defined. One way is to define the increment in traffic as being all interconnection traffic. The second is to define it as the increase in traffic net of that gained from the access provider. For the purposes of the discussion below this distinction is not important.

91. As an interconnection call will contribute to the cost of each of the network elements it uses, network costs directly attributable or incremental to providing interconnection services will be included in interconnection charges.[13] Further, under an element-based approach the cost of interconnection services are only based on the costs of network elements used to provide the services. As a result, interconnection charges will not contribute to network costs that are neither directly attributable nor common to interconnection services (such as the costs of inter-POI transmission links for instance).

Non-network costs

92. Non-network costs directly attributable or incremental to interconnection services are non-network costs that would not be incurred but for the provision of interconnection services. They include for example the costs billing for interconnection services, negotiating interconnection agreements, etc.

93. These costs form part of the annual non-network capital and O&M costs that are attributed to each of the network elements. As interconnection charges will contribute to the cost of each of the network elements it uses, non-network costs directly attributable or incremental to interconnection services will be included in interconnection charges.

Common costs

94. Common costs of providing interconnection services consist of two types:

- common networks costs; and
- common non-network costs.

Network common costs

95. Common network costs are network costs of shared network equipment that are necessarily incurred if interconnection services are provided and are not avoided if interconnection services are no longer provided. They are non-traffic sensitive network costs such as trenches, ducts and switch sites.

[13] It is possible that under an element-based approach interconnection charges may not fully cover directly attributable or incremental network costs. For this to occur however, the average per minute cost of network elements must be less than the incremental cost of using the elements to convey interconnect calls. This is extremely unlikely given the economies of scale and scope in network elements.

96. Under an element-based approach, common network costs are initially allocated to particular network elements. For instance, the costs of trenches are allocated to links between network nodes and the costs of switch sites are allocated to the costs of the switch. These common network costs are then allocated to individual services (including interconnection services) on the basis of the use of those elements. In this way, interconnection charges contribute to common network costs on the basis of network usage (by interconnection services) relative to all other services provided using the network element.[14]

Non-network common costs

97. Common non-network costs are the costs of corporate overheads that are not directly attributable to any particular services, such as accounting and finance, human resource management and so on.

98. Under an element-based approach these costs are also initially allocated to particular network elements and then allocated to interconnection services on the basis of network usage relative to other services.

99. The issue is whether allocating common costs to interconnection services on the basis of network usage constitutes a reasonable allocation of common costs. Allocating common costs in this manner is unlikely to 'first-best' promote economic efficiency. However, allocating common costs in a manner to do so involves significant practical difficulties.[15] Further, the allocation of common costs to interconnection services under an element-based approach has a number of desirable properties.

100. First, all services that use the network elements will share the common network and non-network costs.

101. Second, interconnection charges will not exceed the stand-alone cost of providing interconnection services.

102. This is not to imply that allocating common costs on the basis of network use is in any sense optimal. This approach is somewhat arbitrary and will not result in the first-best economically efficient recovery of these costs.

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[14] As noted below, for some services (such are for leased lines) it is not clear how network use should be defined.

[15] The 'first-best' approach is to allocate common costs across services on the basis of the relative responses of their demands to their prices. Such an approach however requires accurate information on these responses.

Costs incurred in relation to a TSO instrument

103. As noted in Chapter 3 in determining a reasonable allocation of common costs, the Commission must 'not include any costs incurred by the service provider in relation to a TSO instrument'. The methodology proposed in Chapter 3, excludes costs recovered via the TSO provisions from the TSLRIC calculations.

5.2. Network model

104. The costs relevant to determining interconnection charges are restricted to those in the core network. As argued in Chapter 3, interconnection charges should make no contribution to the costs of the access network. That is interconnection charges should only contribute to the costs of conveying interconnect calls to and from the POI to the point of demarcation with the access network.

Point of demarcation between the access network and the core network

105. The point of demarcation between the access network and the core network is at the main distribution frame (MDF). The MDF is the physical point of termination of cables in the access network. One issue typically debated in TSLRIC models is whether line cards should be included as part of the access network or core network. From an economic perspective, the primary difference between the access network and the core network is the driver of costs. Many of the costs in the access network are non-traffic sensitive while many of the costs in the core network are traffic-sensitive. Arguably, most non-traffic sensitive costs should be recovered from 'up-front' fees such as line rental and connection charges and traffic-sensitive costs should be signalled to users through call charges.[16] The number of line cards is a non-traffic sensitive cost.

106. As noted by OFTEL:

> Line driven costs are related to the number of exchanges lines services from the concentrator and include, for example the line card.[17]

107. As a result, the costs of line cards and associated items (such as the line card shelf and frame) should be considered as part of the access network.

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[16] This presumes, among other things, that the decisions of individuals to connect to the network are insensitive to line rental and connection charges.

[17] OFTEL, *Long Run Incremental Costs: The Bottom-Up Network Model, Version 2.2*, March 1997, p.7.

Point of interconnection

108. Points of interconnection are not specified in the definition of designated (interconnection) services. Physically, POIs are likely to be at either a local or tandem switch. The location of the POI is a matter for the parties to negotiate and if not resolved can be the subject of a determination made by the Commission. The Commission is also aware that the level and structure of interconnection charges can potentially affect the points in the access provider's network at which access seekers will seek interconnection. The relevant issue is to ensure that the approach adopted to estimating the TSLRIC of providing interconnection services is sufficiently flexible to estimate the costs where:

- POIs may be located at different parts of the network; and
- conveying calls between the POI and MDF may require the use of varying combinations and types of network elements (for example some interconnect calls may require the use of two local switches).

109. The element-based approach enables these sources of differences in costs to be reflected in interconnection charges. Consider Figure 2. If the POI is located at the tandem switch interconnection charges will comprise cost components for the usage of the remote concentrator, the local switch, the tandem switch, the link between the remote concentrator and the local switch and the link between the local switch and the tandem switch. If the POI is located at the local switch, interconnection charges include cost components for the usage of the remote concentrator, the local switch and the link between the remote concentrator and the local switch.

110. Further, if the MDF is at the local switch (rather than the remote concentrator), then interconnection charges (from a POI at the tandem switch) will include cost components for the local switch (and possibly a host concentrator at the local switch), the tandem switch and the link between the local switch and the tandem switch.

5.2.1. Defining the total service

111. The first issue to be resolved before constructing the network model is the type and quantity of services to be provided (i.e. the **total service** to be provided) by the network.

112. Typically, in TSLRIC models, total service is defined to include all or most services that are provided using the same network elements as interconnection services. This typically includes a range of call services, such as local calls, national toll calls, fixed to cellular calls, etc. Importantly, it includes calls provided by the access provider to its own customers.

113. NERA in constructing a TSLRIC model of Telstra's fixed-line network for the ACCC defined the total service as follows:

> We have taken the service as being the whole of Telstra's inland PSTN and ISDN service together with its leased line (or "private circuit") service. Both Telstra's own customer services as well as traffic for interconnect operators are taken into account.[18]

114. NERA also note:

> Our definition is also consistent with the definition used in the US, UK and other parts of the world.[19]

115. OFTEL, in discussing the development of a long run incremental cost model for British Telecom defined the total service as:

> The network assumed for the purpose of developing the incremental cost methodology is a stand-alone network of inland Public Switched Telephone Network (PSTN) services and inland private circuits. The network assumed in the methodology therefore excludes international and advanced services such as Integrated Services Digital Network (ISDN) and Virtual Private Networks.[20]

116. At a minimum the total service should include the origination and/or termination of the following narrowband voice and data communications services (fixed PSTN services):

- local voice and data calls provided using the fixed PSTN;
- national toll calls;
- international toll calls;
- calls to cellular phones;
- calls from cellular phones;
- toll free calls; and
- interconnection services.

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[18] NERA, *Estimating the Long Run Incremental Cost of PSTN Access, Final Report for the ACCC*, January 1999, page 1.

[19] *Ibid*, page 2.

[20] OFTEL, *Long Run Incremental Costs: The Bottom-Up Network Model, Version 2.2*, March 1997, pages 1-2.

117. These include calls provided to all types of users (business and residential), including those provided by the access provider to its own customers.[21]

118. Each of these services shares many (most) of the elements in the core network.

5.2.2. Other services sharing elements in the core network

119. A key issue is whether the definition of the total service should be broadened to include other services that share elements with fixed PSTN services in the core network.

120. As noted by WIK, in developing a consultative document on cost modelling for the purposes of estimating interconnection costs for the Regulatory Authority of Telecommunications and Posts in Germany:

> We must remember that network elements can be used by circuit-switched services, packet-switched services and leased lines alike. This shared use is of greatest relevance in the transport, or transmission, network since the demand for transport capacity derivable from circuit-switched narrowband services is being augmented by the steadily growing volume of demand from data communications and broadband services, enabling the network operator to make use of higher capacity transmission systems and realise economies of scale per call minute or leased line. (p. 5)[22]

121. Many of the services provided in New Zealand, currently share network elements. For example ISDN (a digital voice and data service) and Centrex (enhanced voice calls) share cables and some switches in the core network with fixed PSTN services. An efficient forward-looking network operator should share network elements between services to avoid duplicating costs. The key issue is how costs common to these other services and fixed PSTN services (including interconnection services) should be allocated.

Options for the treatment of other services

122. The Commission has three options in regard to the treatment of other services.

Exclude other services

123. One option is to exclude other services from the methodology to estimate TSLRIC of providing interconnection services.

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[21] It should also include any services provided by the access provider for its own internal use.

[22] WIK, *An Analytical Cost Model for the National Core Network – Consultative Document – Prepared by WIK foot the Regulatory Authority for Telecommunications and Posts*, 14 April 1999.

124. The element-based approach estimates the cost of the total service on a stand-alone basis. That is the cost of providing the total service is estimated assuming the provider provides no other services. As a result, excluding other services will result in all costs common to the total service and other services provided by the provider being fully allocated to the former (including interconnection services).

125. Say the total service is limited to fixed PSTN services. The stand-alone cost of providing these services will be modelled. Although costs common to individual fixed PSTN services will be shared across those services, the model will not share costs common to say fixed PSTN and ISDN services. Rather, these costs will be fully allocated to the former (including interconnection services).

126. The Commission is of the view that excluding services that share network elements with interconnection services will most likely not result in a reasonable allocation of common costs.

Include other services in the network model

127. A second option is to include other services as part of the network model.

128. There are two potential difficulties in including services such as ISDN and leased line services in the network model.

129. The first potential difficulty is determining the basis upon which to allocate common costs between other services and interconnection services. It is relatively straightforward to identify the network elements used by other services. The potential difficulty is determining the 'usage' of the network elements by other services. For example, as leased lines are dedicated links, there is no minutes of use of network elements as there are for interconnect calls. As a result, the use of network elements by leased lines must be proxied by other measures such as leased line capacity. That is the costs of shared network elements must be allocated between leased lines and fixed PSTN services (including interconnection services) on the basis of the capacity of the equipment used to provide the services.

130. The second potential difficulty is the additional complexity in adding other services to the network model. One particular difficulty is distinguishing costs that are directly attributable to providing fixed PSTN services and other services (such as ISDN services). For instance, it is the Commission's understanding that different remote concentrators are required for ISDN services and fixed PSTN services. Ideally, fixed PSTN services (including interconnection services) should not contribute to the costs of remote concentrators that directly result from the provision of ISDN services. However, as directly attributable costs are not identified under an element-based approach separating out these costs can be difficult in practice.

Determine an allocation to common costs to other services separately from the network model

131. A third approach is to determine the contribution of other services to common costs 'outside the model'. This involves the following steps.

132. **Step 1:** Identify each of the services that share core network elements with fixed PSTN services.

133. **Step 2**: Identify the core network elements each of the services share with fixed PSTN services

134. **Step 3**: Determine the costs of the core network elements that are common to each of the services and fixed PSTN services

135. **Step 4**: Determine an allocation mechanism to determine the contribution of each of the services to these common costs.

136. The aim of the second and third approaches is the same, that is to determine a reasonable contribution from other services to the common costs of providing interconnection services. As there are practical difficulties with both of these approaches, which approach is adopted is probably best left to the modelling work.

The Commission seeks comment on:

- the services that should be included in the network model;
- any practical difficulties in including particular services (such as ISDN services) in the network model; and
- approaches to allocating common costs between interconnection services and services excluded from the network model

5.3. Determining the level of geographic aggregation

137. Although it is conceptually possible to determine the cost of originating and terminating calls from each POI, the information required and the modelling complexity are likely to be significant. Further, even if such a modelling exercise was achievable, estimates of the interconnection costs from each POI are likely to be subject to significant error. As a result, it may be inadvisable to base interconnection prices on these individual costs.

138. A more practical approach may be to model cost differences by geographical regions. Reasons for this include encouraging efficient investment decisions (refer to the discussion in Chapter 11) and enabling the model to be used to determine charges for interconnection with fixed PSTNs

with limited geographic coverage (refer to Chapter 12). On the other hand this approach can add complexity and cost to the modelling process.

139. Differentiating interconnection prices by geographic area would require the Commission to initially classify points of interconnection into groups in accordance with their locations.

140. The costs of interconnection services are likely to differ across POIs based on a range of factors including:

- the average distance between the POI and the MDF;
- the network elements used to provide the service (i.e. whether or not a remote concentrator is used);and
- the costs of installing network infrastructure (such as the costs of trenches and laying cable).

141. Classifying POIs into geographic 'cost' groups involves classifying POIs according to these characteristics. Arguably, the number and definition of the groups is best determined by the modeller. In doing so, the modeller should consider at least three key factors.

142. First is the likely size of the differences in costs and whether or not the differences are significant. It is likely to be advisable to separate POIs if there are significant differences in costs. This is only likely to be revealed once the analysis has commenced.

143. Second is the size of the POIs. If a group of POIs are to be separated based on geographic cost differences, the interconnection traffic through this group should be significant. There is little gain in separately costing interconnection for a group of POIs that constitutes an insignificant proportion of total interconnection traffic.

144. Third, is the information available. The scope for the modeller to differentiate between the costs of interconnection services across POIs depends on the information available. It is only possible to separate POIs if the required information is collected at a sufficient level of disaggregation.

The Commission seeks comments on the appropriateness of having geographic deaveraging of interconnection costs.

Further, the Commission seeks views on:

— the appropriate level of geographic deaveraging of interconnection costs;

- extent to which the costs of providing interconnection services are likely to differ by geographic area; and

– sensible classifications of POIs into geographic 'cost' groups.

5.4. Determining the technology

145. As noted in chapter 3, it is the Commission's preliminary view that forward-looking costs should be based on a scorched node assumption of network design, where the locations of network nodes are taken as given, but the technology used at each node and the type of transmission connecting the nodes will be optimized. It is also the Commission's preliminary view that forward-looking costs should reflect the costs of providing services using best-in-use technology with modern equivalent assets.

5.5. Dimensioning the network

146. A key issue in constructing the network model is the dimensioning of network components (switches and transmission links) required to convey calls between the MDF to the POI. Although by necessity network dimensioning will be left to the modelling stage, it is helpful to discuss here the issues relevant to determining those dimensions and some of the possible approaches.

Nodes

147. There are likely to be three types of nodes in a TSLRIC model:

- Remote switches and host concentrators;
- local switches; and
- tandem switches.

The Commission seeks comments on the appropriateness of including access transmission and traffic concentration systems as nodes within a TSLRIC model.

148. The costs of a switch depend upon traffic processing and port capacity. Traffic costs are the costs to switch calls during the busy hour and port costs are driven by the volume of calls in and out of the switch to other switches during the busy hour.

149. Costs of remote concentrators consist of two parts. One part are line-related costs (for example, the cost of the line card). The other part are traffic-related costs (such as the costs of traffic concentration).

Transmission

150. Four types of transmission links are likely to be modelled in a TSLRIC model:

- remote concentrator to host switch (which can be a local or tandem switch);
- local switch to tandem switch;
- local switch to local switch; and
- tandem switch to tandem switch.

151. These links should be digital links using fibre cables in ducts or directly buried, or radio systems. As with switching, the capacity of the transmission links is primarily driven by traffic during the busy hour.

5.5.1. Issues in dimensioning concentrator, switching and transmission capacity

152. A number of issues need to be addressed in determining the required capacity of concentrators, switches and transmission links in the core network.

Dimensioning to cater for peak network demand

153. Dimensioning the core network to cater for peak demand raises two issues. The first is to define peak demand (or average busy hour traffic). The second is to determine the appropriate contingency to cater for demand in excess of average busy hour traffic.[23]

Average busy hour traffic

154. Two factors define busy hour call traffic, busy hour call attempts and busy hour erlangs (which are determined by the average duration of calls during the busy hour). Modelling network costs requires information on calls (successful and unsuccessful) and average call duration during the busy hour (as well as over the whole year). Ideally this information should be collected by equipment type and by geographic 'cost' area. The aim is to determine the demand placed on each network element type in each area.

155. In order to do this however it is necessary to define busy hour traffic. As noted by WIK:

[23] It should be recognised that network load is likely to be affected by the level and structure of interconnection charges themselves. It may be necessary to take this into account in provisioning for demand uncertainty.

> Network dimensioning requires data on demand in the busy hour. Traffic load in the busy hour is defined as the average of the n hours of highest demand in any one year. Part of the cost analysis is then to define n.[24]

156. A related issue in determining traffic in the busy hour is whether peak days (such as Christmas Day) should be excluded.

Traffic in excess of average busy hour traffic and acceptable blocking margins

157. Busy hour traffic defined above is likely to provide an estimate of the average busy hour traffic. However, it will not necessarily capture the potential for traffic to exceed average busy hour traffic on specific days (such as Christmas Day). It may be necessary to provision for such occurrences. The required provisioning (over and above that necessary to meet average busy hour demand) will depend on the distribution of busy hour demand (over the year) and acceptable blocking margins during those times.[25]

The Commission seeks comments on appropriate rules for dimensioning the core network to meet demand during the busy hour. The Commission particularly seeks comment on:

— the appropriate way to define average busy hour traffic; and

— the provisioning to allow for traffic in excess of average busy hour traffic.

Dimensioning to ensure network resilience

158. Some core network elements may require additional capacity to ensure traffic is not lost and service can be continued in the event of the failure of a transmission link or a switch. For example, it may be necessary to provision additional transmission capacity within a ring of switches to allow for alternative routings of traffic in the event of switch or transmission failure.

The Commission seeks comments on whether capacity is required to ensure network resilience. If parties consider that such provisioning is consistent with efficient network design, then the Commission seeks comment on:

— which network elements require such provisioning; and

— the appropriate provisioning 'margin' for each of these elements to provide for network resilience.

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[24] WIK, *An Analytical Cost Model for the National Core Network – Consultative Document – Prepared by WIK foot the Regulatory Authority for Telecommunications and Posts*, 14 April 1999, p.9.

[25] Blocking margins are the percentage of calls that fail due to network congestion.

Dimensioning for equipment modularity

159. Switching and transmission capacity is lumpy. For instance, transmission capacity comes in 2Mbit/s, 34Mbit/s, 140Mbit/s and larger blocks. Switching ports come in blocks of 2Mbit/s (30 circuits). As a result, at any time, some unused capacity will occur.

Dimensioning for demand growth

160. It is efficient for network operators, when investing in equipment in the core network, to provision for future as well as current levels of demand. An efficient network operator will trade-off the costs of provisioning additional capacity today (and hence incurring costs ahead of demand) against the cost of having to install additional capacity in the future. For example, consider the costs of transmission cables. A large proportion of the cost of these cables is the cost of installing them. It is likely to be efficient to install capacity ahead of demand rather than incur the costs of installing (smaller) cables two or three times.

161. Two issues need to resolved in dimensioning for demand growth. The first is determining the efficient dimensioning for demand growth. The second is determining how the costs of the additional capacity are to be recovered over time.

Efficient dimensioning for demand growth

162. Efficient dimensioning for demand growth will differ according to a range of factors including the costs of the capacity installed ahead of demand and the costs of adding capacity. For instance, it is the Commission's understanding that digital switches are initially provisioned to meet forecast demand for a period of say five years, with additional capacity added at that time. The same is not the case for transmission links, with capacity installed to meet forecast demand in excess of five years.

163. Decisions on how much capacity to install are often based on network planning studies that consider anticipated demand and equipment and installation costs. Typically in TSLRIC models a capacity margin over current demand is included to capture the provisioning for demand growth.

The Commission seeks comments on the appropriate capacity margins for demand growth for each type of equipment in the core network. In detailing these margins the Commission is interested in the underlying assumptions concerning the:

– anticipated rate of demand growth; and

– length of time before additional capacity will be required.

Recovering the costs of capacity for demand growth

164. Once the efficient dimensioning of network elements for demand growth is determined, the second issue is how the costs of the capacity should be recovered over time. It should be noted that a network operator's investment decisions may be affected by the way in which access providers are compensated for holding spare capacity.

165. At any point of time in an efficient network some services are provided using capacity (efficiently) installed in the past. That is the costs of providing fixed PSTN services today (including interconnection services) includes the opportunity cost of the funds invested in capacity ahead of today's demand. The opportunity cost of these funds are part of the cost of providing the services today. As a result, they are a legitimate part of TSLRIC.

166. The difficulty is determining this cost. It depends on a range of factors, including when the capacity used today was installed, the cost of funds at that time and so on.

167. A practical way of addressing this difficulty is to determine an 'average' capacity margin that is likely to occur over the period the additional capacity comes on stream. So for example, if a 20 per cent margin is installed into the capacity of a switch to cater for demand growth over a period of say 5 years, the average additional capacity is around 10%.[26] This approach has three desirable properties.

168. First, it is likely to be relatively simple to implement.

169. Second, it will enable the access provider to recover the efficient costs of provisioning for demand growth.

170. Third, it will result in stable interconnection prices over time.

The Commission is of the preliminary view that the network should be dimensioned to include provisioning for demand growth. The difficulty is spreading the cost of this capacity over the period in which it is used. Over time the capacity installed ahead of demand will differ. One approach is to assume that one half of the efficient capacity for demand growth is being used at any one time. The Commission seeks comments on this approach.

[26] This assumes that the rate of growth of demand in each of the five years is about the same.

5.5.2. Design capacity utilisation or fill factors

171. As a result of the factors mentioned above, at any point of time network elements will have spare or unused capacity. Furthermore, this is efficient. Spare capacity is:

- necessary to cater for unexpected increases in demand;
- necessary to ensure network resilience;
- the result of equipment modularity; and
- necessary to efficiently service future demand.

172. There are two approaches to modelling these factors. One is to model each separately on the basis of information concerning demand, demand growth, demand variability, equipment sizes, etc. This is the approach detailed above.

173. A second approach is to 'aggregate' a number of these factors into design capacity utilisation or fill factors. This involves:

- determining the capacity to meet demand in the busy hour;
- adding an amount of capacity to meet the design fill factors; and
- determine the required equipment size.

174. The design fill factors capture provisioning for demand uncertainty, network resilience, demand growth, etc. Although this may be a useful 'short-cut' care must be taken. It is necessary to ensure that provisioning for particular factors is not made twice. Further, one must be sure what the fill factors represent (for example do they capture provisioning for demand growth at the time of installation, or an average over the life of the equipment, etc.). Which approach is taken is largely a modelling issue.

The Commission seeks comment on:

– whether each of the factors that necessitate the provisioning of spare capacity should to be modelled separately; or

– whether an 'aggregate' fill factor should be used to capture the effects of all of the factors.

5.6. Other network modelling issues

175. A number of other network modelling issues also need to be resolved in developing the network model.

5.6.1. Elements shared by the access and core networks

176. One such issue is the sharing of network elements between the access and core networks. Although many of the network elements in the core and access networks are separate, they often share trenches and ducts. As noted by OFTEL:

> Some duct in the network will carry both fibre for transmission and copper for local loop. Such duct constitutes a source of costs that are common between conveyance and access.[27]

177. Typically in TSLRIC models these common costs are allocated to the access and core networks on a 50/50 basis. However, as noted above, in determining a reasonable allocation of common costs, the Commission must 'not include any costs incurred by the service provider in relation to a TSO instrument'.

The Commission's preliminary view is that costs common to both the access and core networks related to a TSO instrument should be entirely excluded from TSLRIC calculations. The Commission seeks comment on this approach.

5.6.2. Sharing of elements in the core network

178. Another issue is the sharing of trenches and ducts in the core network. The logical routes of links between network nodes allow for the sharing of trenches and ducts in the core network. For example, a link between a local and tandem switch may share part of the trenches and ducts with links between two local switches. These opportunities must be taken into account in costing the core network.

5.6.3. Trench sharing in the core network

179. To the extent there are opportunities for the sharing of trenches in the core network with other telecommunications companies and utilities, these should be captured in the network model. The Commission needs to resolve two issues here.

180. First, is the amount of trench sharing. There are two possible approaches the Commission can take. One is to use the access provider's actual trench sharing in the core network. The other is to estimate the trench sharing an efficient operator would or could undertake. Implicit in this choice is whether the Commission considers the opportunities for trench sharing that exist today or those when the network was constructed as being appropriate.

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[27] OFTEL, *Long Run Incremental Costs: The Bottom-Up Network Model, Version 2.2*, March 1997, p.21

181. Second, is the sharing of the costs of trenches. Again there are two practical approaches the Commission can take. One is based on charges to third parties for trench sharing. The other shares the costs across the number of parties sharing the trenches. The first approach is based on market prices for trench sharing and hence has appeal.[28]

The Commission seeks comments on the:

– scope for the sharing of trenches in the core network with other telecommunications companies and utilities; and

– appropriate approaches to sharing the cost of trenches between the access provider and other parties using the trenches.

[28] One potential problem with this approach is that it is not necessarily the case that trench sharing is sufficiently standardised for these market prices to be meaningful.

6. Asset valuation

182. In order to estimate the TSLRIC of providing interconnection services, the Commission must determine the value of the network and non-network assets used to provide those services. Network and non-network capital costs constitute a considerable component of the costs of providing fixed PSTN services (including interconnection services).

6.1. Methods of asset valuation

183. There are a number of potential asset valuation methodologies that could be used to value network and non-network assets, including opportunity cost, historic cost, replacement cost, or optimal deprival value. Each of these methods is briefly discussed below.

Opportunity Cost

184. The opportunity cost of committing resources to a particular activity is the value of those resources in their best alternative use. In other words, opportunity cost refers to the highest value of an opportunity forgone.

185. Opportunity cost is the relevant starting point in economic decision-making. The cost of resources tied up in one input or asset is based on what is forgone by not being able to employ those resources in an alternative use. The Commission has previously noted, however, that the use of opportunity cost will likely discourage efficient investment in the presence of sunk costs:

> …a problem arises when an asset is 'sunk'; that is to say, it is so specialised that it has no significant alternative use. Once the investment has been made, the cost cannot be recouped by re-selling the asset, except as for scrap. In such instances, the opportunity cost of the asset is very low, as the owner forgoes very little by employing the asset in its present use. Including the asset in the asset base for pricing purposes at its opportunity cost would not enable the asset owner to recover their costs and would discourage future investment in sunk assets.[29]

186. A significant proportion of network assets are largely irreversible once committed. That is they are sunk costs. Valuing assets on the basis of opportunity cost will likely discourage efficient investment by access providers in fixed PSTNs.

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[29] Commerce Commission, *Draft Report: Price Control Study of Airfield Activities at Auckland, Wellington and Christchurch International Airports*, July 2001, page 93

Historic Cost

187. The historic cost of an asset refers to the original cost incurred in acquiring or building the asset. The use of historic costs has an advantage in that they are usually easily quantified and based on objective data, which can be independently audited. However, in circumstances where there are long-lived assets, and in particular where technology is rapidly advancing, historic costs are unlikely to reflect the forward-looking costs of providing the service.

Optimised Replacement Cost

188. Optimised replacement cost (ORC) is the present-day cost of acquiring an asset to efficiently provide the required quantity and quality of service. Replacement cost is based on current market costs. Further, as replacement cost is based on the costs of acquiring an asset (not necessarily the existing asset) in order to provide the service, it can incorporate the availability of current technology. Optimised depreciated replacement cost (ODRC) is ORC written down for past depreciation.

Optimised Deprival Value

189. The optimised deprival value (ODV) of an asset is the cost to the asset owner if deprived of the asset. In practice, ODV equals the depreciated replacement cost, except where the asset would not be replaced. If the rational choice is not to replace the asset, then the ODV of the asset is equal to the economic value of the asset, where the economic value is the present value of expected net income.

6.2. Which Valuation Methodology to Use

190. As noted above, the potential detrimental effects on investment of valuing assets on the basis of opportunity cost make it inappropriate.

191. As noted in the *TSO Implementation Issues Paper* this differs from the approach to asset valuation used by the Commission in its draft airfield activities decision. In that report the Commission's preliminary view was that specialised airfield assets, such as runways, taxiways, and aprons, should be valued at historic cost.[30]

192. However, valuing assets on the basis of historical costs is unlikely to provide an estimate of forward-looking replacement costs. There are a number of reasons for this.

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[30] Commerce Commission, *Draft Report: Price Control Study of Airfield Activities at Auckland, Wellington and Christchurch International Airports*, July 2001

193. First, the assets currently used to provide the services may not be modern equivalent assets that will be used to provide the services in the future. As noted by the ACCC:

> …in telecommunications where technology advances rapidly, historically incurred expenditures often have little relationship with (and generally overstate) the true economic costs of replicating an asset's service potential.[31]

194. Fixed PSTNs are likely to be a hybrid of assets of differing vintages. As providers replace network elements such as switches they may choose not to replace them with the same equipment or vintages.

195. Second, even if the assets were to be replaced by the same asset, historical costs will not capture the current and future cost of purchasing and installing that equipment. Technological improvements have resulted in substantial decreases in the real cost of network equipment. For example, advances in computing technology have substantially reduced the real cost of switching equipment. Further, the cost of installing the equipment has changed over time. Changes in labour costs and the technology used to install equipment (such as trenching equipment) have altered installation costs over time.

196. Third, changes in technology and the relative costs of equipment have affected the mix of equipment used in telecommunications networks. For example, the increase in the use of fibre over copper cables in transporting calls. The mix of current network assets may not reflect such efficiencies.

197. Typically in bottom-up TSLRIC models network and non-network assets are valued according to their optimised replacement cost. As noted by the ACCC:

> Estimating TSLRIC requires assets to be valued at their economic costs. There is a variety of methods of asset valuation .....Of these methods, replacement cost is the methodology most consistent with TSLRIC.[32]

198. Valuing assets on the basis for optimised deprival value can potentially create a circularity as, in the event an asset will not be replaced, its value will depend on the interconnection price.

199. In Chapter 7 of the *TSO Implementation Issues Paper* the Commission expressed the preliminary preference for valuing TSO assets at replacement costs. Reasons included consistency with the purposes of the Act and consistency with the approach taken by overseas regimes. The Commission

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[31] ACCC, *Access Pricing Principles – Telecommunications: a guide*", 1997, page 43

[32] (ACCC *Access Pricing Principles, Telecommunications - a guide July 1997*, p. 41

sought feedback on the appropriateness of optimized replacement costs (ORC) or optimized depreciated replacement costs (ODRC). Opportunity cost was considered inappropriate for TSO purposes due to the specialised nature of the assets required and the associated sunk costs. Historic cost was seen as problematic given the industry's mix of long asset lives and rapid technological change.

As with costing the TSO, the Commission proposes to use an optimised replacement cost methodology to value assets in estimating the TSLRIC of providing interconnection services. The Commission seeks comments on this approach.

7. Depreciation

200. The rate of depreciation determines the rate at which the costs of an investment are recovered over time. For example, if an access provider invests $10m in a switch, the rate of depreciation determines the rate at which the $10m is recovered over time. The rate of depreciation therefore determines the **rate of return of capital**.

201. The Commission must determine:

- the depreciation methodology; and
- the parameters necessary to implement that methodology (such as the asset lives).

7.1. Determining the depreciation methodology

Relationship between return on capital and return of capital

202. In determining the depreciation methodology, it is necessary to recognise that the choice of methodology will affect both the **return of capital** (depreciation) and the **return on capital**. The return on capital is the rate of return on the funds invested in a fixed PSTN. Over time, as some of the funds invested are 'returned' through depreciation charges, the required return on capital falls.

203. An example may assist. Say a set of switches costs $100m. Assume the costs are to be recovered over 10 years. Table 2 details two depreciation profiles. Under Profile 1, the return of capital is the same in every year. Under Profile 2, depreciation is greater in the first three years. Under both profiles, total depreciation equals the purchase or current replacement cost of the switches ($100m).

204. As the switches are depreciated, their value falls. Under profile 1, the asset base decreases by $10m per year. Under profile 2, the asset base decreases at a more rapid rate in line with the initial higher rates of depreciation. In turn, the return on capital falls. The return on capital shown in Table 2 are based on a cost of capital of 12% per annum.

205. The depreciation rate affects the total capital cost (return of capital *plus* return on capital) in two ways. First through the depreciation charge itself. Second through the return on capital. The greater the depreciation rate, the more rapidly the return on capital decreases over time.

206. Given this interdependency, it is necessary to consider the choice of depreciation methodology in terms of how it affects the total capital costs (the return of capital and the return on capital), rather than just the return of capital.

Table 2: Hypothetical depreciation profiles

	Profile 1					*Profile 2*				
Year	*Return of capital ($m)*	*Asset base ($m)*	*Return on capital ($m)*	*Total capital cost ($m)*	*Present value of capital cost ($m)*	*Return of capital ($m)*	*Asset base ($m)*	*Return on capital ($m)*	*Total capital cost ($m)*	*Present value of capital cost ($m)*
1	10	100	12	22	19.6	25	100	12	37	33
2	10	90	10.8	20.8	16.6	20	75	9	29	23.1
3	10	80	9.6	19.6	14.0	20	55	6.6	26.6	18.9
4	10	70	8.4	18.4	11.7	5	35	4.2	9.2	5.8
5	10	60	7.2	17.2	9.8	5	30	3.6	8.6	4.9
6	10	50	6	16	8.1	5	25	3	8	4.1
7	10	40	4.8	14.8	6.7	5	20	2.4	7.4	3.3
8	10	30	3.6	13.6	5.5	5	15	1.8	6.8	2.7
9	10	20	2.4	12.4	4.5	5	10	1.2	6.2	2.2
10	10	10	1.2	11.2	3.6	5	5	0.6	5.6	1.8
Total	100			166	100	100			144.4	100

Scope for access providers to recover the costs of prudent investment in fixed PSTNs

207. In determining the depreciation methodology and the depreciation parameters (such as asset lives), the primary concern of the Commission is to select a methodology that:

- enables access providers to recover the cost of prudent investment in providing interconnection services; and
- does not over-compensate access providers.

208. Investments in fixed PSTN infrastructure are mostly long-lived and irreversible. In order to allow access providers to recover the cost of prudent investment, they must have the expectation of recovering the costs of such investment over the period in which the assets can usefully be used to generate revenues. This requires that the present value of revenues achieved from the infrastructure (net of operating and other non-capital costs) are sufficient for the access provider to recover the up-front cost of the investment. In considering this it is necessary to keep in mind that the relevant expectation of returns are the expectations when the investment is made, not the returns after the event.

209. The net present value of the revenues from an investment is:

$$\text{NPV}^{33} = \sum_{t=1}^{N} \frac{Net\ revenue_t}{(1+r)^t}$$

where Net revenue$_t$ is revenue less non-capital costs in year t;

r is the return on funds;

t is the year, and

N is the life of the assets

210. Enabling cost recovery is consistent with an infinite number of depreciation profiles. Consider the depreciation profiles detailed in Table 2. Although the present value of the capital costs are the same ($100m) under both profiles, the timing of the costs differ. Basing revenues on these costs will result in higher revenues in the early years of the life of the assets under Profile 2 than Profile 1.

Box 2: Common depreciation methods

There are a vast array of depreciation methods. This box describes some of those commonly used to determine regulated prices. For purposes of exposition it is assumed that the current replacement cost of the asset is P and the asset life is N. It is also assumed that the asset has no scrap value.

Straight line depreciation – Under straight line depreciation, depreciation is the same amount each year. The annual depreciation amount is $\frac{P}{N}$.

Straight line depreciation with tilt – Straight line depreciation with a tilt takes into account changes in the replacement cost of the asset over time. Depreciation is accelerated (i.e. greater rates of depreciation early in the life of the asset) if the replacement cost of the asset is decreasing over time.

Declining balance depreciation – Under declining balance depreciation, depreciation is set as a percentage of the asset value.

Sum of years digits depreciation (front-loaded) – Under this depreciation approach depreciation rates are greatest in the first year and gradually decrease over time. Depreciation in the first year is $\frac{(PN)}{(N+N-1+N-2+\cdots\cdots+1)}$.

[33] This formula assumes that the revenues accrue at the end of each year.

In the last year it is $\frac{P}{(N+N-1+N-2+\cdots\cdots+1)}$.

Sum of years digits depreciation (back-loaded) – This gives the reverse of the depreciation under sum of years digits (front loaded). Depreciation in the first year is $\frac{P}{(N+N-1+\cdots\cdots+1)}$ increasing to $\frac{(PN)}{(N+N-1+\cdots\cdots+1)}$ in the last year.

Standard annuity – Under the standard annuity approach capital costs (depreciation plus the return on capital) are determined within the same formula. The capital costs are the same in each year of the life of the asset.

Tilted annuity – Under the tilted annuity approach the capital costs are higher or lower early in the life of the asset depending on whether the replacement cost of the asset is rising or falling over time. If the replacement cost of the asset is declining over time the capital costs are higher early in the life of the asset and decline at the rate of decline of the replacement cost. The opposite is the case if the replacement cost of the asset is rising over time.

7.2. Appropriate depreciation profile for TSLRIC

211. Under the Act, the Commission will be required to determine interconnection prices on the basis of TSLRIC if:

- the access provider and an access seeker cannot agree on the price; and
- one of the parties seeks a review of the Commission's initial determination.

212. Such events are likely to occur at irregular intervals, or may not occur at all. In order for the access provider to have the expectation of recovering the costs of prudent investment, without 'over-recovering' those costs, the Commission must ensure 'consistency' in its pricing determinations over time. In each pricing determination the Commission proposes to value the assets on the basis of optimised replacement cost. Given the rapid rate of technological change in telecommunications networks it is likely that ORC will decrease in real terms over time. In order for access providers to be able to recover the costs of prudent investment in such circumstances, the depreciation of the asset must be 'front-loaded'. That is access providers must recover a high proportion of the cost of the asset early in its life before its value declines with improvements in technology. Specifically, the 'front-loading' of the depreciation rates must be consistent with the rate of decline of the replacement cost of the asset. The more rapid the rate of decline of ORC, the more the depreciation must be 'front-loaded'.

213. If access providers are required at any point in time to provide access to their networks at prices that reflect the network costs valued on an ORC

basis, then the only way to ensure that the costs of investments can be recovered (but not over-recovered) is to base depreciation on a tilted annuity, where the 'tilt' is based on the rate of change of the ORC. Under a tilted annuity the capital cost (return on funds and return of funds) in each year is given by

$$\frac{V[1+\alpha]^{t-1}[r-\alpha]}{1-\{(1+\alpha)/(1+r)\}^{N}}$$

where r is the return on funds;

α is the rate of change of the replacement cost of the asset;

t is a particular year in the economic life of the asset; and

N is the economic life of the asset; and

V is the current replacement cost of the asset.

214. The tilted annuity 'bundles' depreciation and the return on funds into a single amount. It adjusts the capital costs over time in line with the rate of increase or decrease of the replacement cost of the capital equipment. The capital costs under a tilted annuity are detailed in Table 3. It is assumed that the replacement cost of the asset decreases at a rate of 5 per cent per annum. Under a tilted annuity the capital costs will decline in each year in line with the decline in the ORC of the asset.

215. The Commission seeks views on whether the tilted annuity approach is the appropriate depreciation methodology in the event that it is considered appropriate to value assets on the basis of optimised replacement cost. The Commission also seeks views on whether other methods of depreciation may be more appropriate. Such approaches should be consistent with the approach taken to the valuation of assets.

Table 3: Tilted annuity

Year	*ORC ($m)*	*Return of capital ($m)*	*Return on capital ($m)*	*Total capital cost ($m)*	*Annual percentage change*	*Present value of capital cost ($m)*
1	100	9.1	12.0	21.1	-5.0	18.8
2	95.0	9.1	10.9	20.0	-5.0	15.9
3	90.3	9.2	9.8	19.0	-5.0	13.5
4	85.7	9.3	8.7	18.1	-5.0	11.5
5	81.5	9.6	7.6	17.2	-5.0	9.7

6	77.4	9.8	6.5	16.3	-5.0	8.3
7	73.5	10.2	5.3	15.5	-5.0	7.0
8	69.8	10.7	4.0	14.7	-5.0	5.9
9	66.3	11.2	2.8	14.0	-5.0	5.0
10	63.0	11.9	1.4	13.3	-5.0	4.3
Total	177		100	169		100

7.2.1. Determining the parameters of a tilted annuity

216. In order to estimate capital costs using a titled annuity, the Commission must determine the:

- lives of capital equipment (N); and
- rate of change of the replacement cost of capital equipment (α).

Asset lives

217. The life of an asset should be based on the **expected** number of years the asset is likely to remain in service or the expected number of years the asset is likely to generate revenue. This is the economic life of the asset. The economic life of the asset depends on a range of factors.

218. First is the physical service life of the asset. At some point of time most assets deteriorate to a point where they cannot be used to provide the same level of service. This is often referred to as physical obsolescence.

219. Second is the technical life of the asset. It may be more efficient for an asset to be replaced with more up-to-date technology before the end of its physical life. For example, if operating and maintenance costs using an up-to-date technology are lower, it may be efficient to 'bring forward' the replacement of the asset. This is often referred to as technical obsolescence.

220. Third is the expected commercial life of the asset. The commercial life of an asset is primarily determined by demand. Say for example an access provider builds infrastructure to provide fixed PSTN services to customers in a particular area (such as a mining community) knowing that the demand for the services will be short-lived. The period over which the assets will generate revenue will be limited by the life of the demand for the services.

221. There are three options to determining asset lives in practice. They are:

- asset lives used by the access provider in its accounts;
- expected physical assets lives based on engineering specifications; and
- 'estimates' of economic lives of the assets.

Assets lives used by the access provider in its accounts

222. Although readily identifiable, asset lives used by the access provider in its accounts are likely to be the least appropriate. These lives are likely to be affected by a range of factors including taxation laws and the taxation position of the company. As a result they are unlikely to represent the economic lives of the assets.

Expected physical assets lives

223. The expected physical life of an asset forms an upper bound to its expected economic life. The advantage of using the expected physical life is that it is transparent and can be readily obtained from the engineering specifications. However, to the extent it over estimates the expected economic lives of the assets, it will systematically bias downward the capital costs. Consider the profile of capital costs under the tilted annuity detailed in Table 3. Assume that the expected physical life of the asset is 10 years, but the expected economic life is 9 years. Using an expected life of 10 years rather than 9 years will generate capital costs (that can be recovered by the access provider) that have a present value of $95.7m ($100m *less* $4.3m). As this is below the initial investment cost of the asset ($100m), the access provider will be under compensated for the investment.

'Estimates' of economic lives

224. Estimating the expected economic life of the asset is likely to involve a degree of subjectivity. Although the engineering life can be used as a starting point, the difficulty is to determine how much the asset life should be shortened to reflect the stranding of assets as a result of technological change or through changes in demand.

The Commission seeks comments on practical ways and difficulties in estimating the economic lives of assets. If it is impractical to estimate the economic lives of assets, the Commission seeks comments on alternative approaches to determining asset lives.

Rate of change of the replacement cost of capital equipment

225. The second parameter to be estimated is the rate of change of the replacement cost of capital equipment. This needs to be estimated for the economic life of each asset. In doing so it is important to recognise that replacement cost is affected by both changes in the price of the equipment and changes in technology..[34]

[34] This complicates matters. For instance, the introduction of WDM that boosts the capacity of fibre-optic cables will reduce the costs of a given amount of transmission capacity.

226. Without doubt such estimates will be subject to error. Two sources of evidence should inform such estimates. The first is changes in the price of capital equipment in the recent past. The second is industry expectations of the likely changes in these prices (for example the expectations of equipment manufacturers and suppliers). The first source of evidence is likely to be more transparent. However, where considered appropriate it should be supplemented by verifiable information on industry expectations.

The Commission suggests that the rate of change of the replacement cost of assets should be based on recent trends in the purchase prices of capital equipment. The Commission seeks comments on this approach and how it could be best implemented in practice.

8. Return on funds

227. An important component of estimating TSLRIC is the return on funds or the cost of capital. The cost of capital is the cost of the funds invested in network and non-network assets. The cost of capital used by the Commission will have important implications for the incentives for access providers to invest in the assets to provide interconnection services.

228. The appropriate cost of capital is the opportunity cost of the funds in the market. That is the expected rate of return an investor would expect to achieve in the market from investing in assets with a similar risk profile. If the Commission sets a cost of capital below this return, then investors will prefer to invest in other assets. As the access provider will not achieve the return it could achieve in the market, its incentives to invest in assets to provide interconnection services and fixed PSTN services more broadly will be undermined. Under investment will potentially result.

229. A key issue in determining the appropriate cost of capital is to determine the costs of the risks faced by the access provider. Two sorts of risk are examined in this chapter. The first is non-diversifiable risk. This is the risk that the investor cannot eliminate by holding a diversified portfolio of assets. This type of risk is traditionally estimated using the Capital Asset Pricing Model (CAPM). Second are risks that are introduced by the nature of access regime. These risks (known as regulatory or asymmetric risks) can result from the unintended effects the regime has on the returns to the investor.

230. The Commission has previously examined the cost of capital in relation to airport pricing. As many of the issues in determining the appropriate cost of capital are relevant to all regulated industries, the Commission does not start with a blank slate. Furthermore, although the Commission is willing to reconsider its position on common issues, it sees considerable merit in maintaining a consistent approach. As a result, parties in providing submissions on cost of capital issues are encouraged to consult the considerations of the Commission in Commerce Commission, *Price Control Study of Airfield Activities at Auckland, Wellington, and Christchurch International Airports*, Draft Report, July, 2001,which will be referred to in this report as the "draft airfield activities decision").

8.1. Weighted Average Cost of Capital

231. Typically, regulators determine the appropriate cost of capital on the basis of the weighted average cost of capital (WACC). The WACC is a weighted average of the cost of debt and equity faced by the firm. Consistent

with regulatory practice elsewhere, the Commission in estimating the appropriate cost of capital in the draft airfield activities decision used a vanilla WACC.[35] The vanilla WACC[36] is

$$WACC = r_e \frac{E}{V} + r_d (1 - T) \frac{D}{V}$$

where

r_e is the return on equity;

r_d is the return on debt

T is the marginal corporate tax rate;

E is the market value of equity;

D is the market value of debt; and

V is the market value of debt plus equity.

232. This defines the WACC in nominal post-tax terms. That is the cost of capital after the payment of company tax, but before the payment of personal income tax.

8.1.1. Return on equity

233. The return on equity (r_e) captures the return required by equity holders to willingly invest in the firm. Typically, the return on equity is estimated using the CAPM. Applying the CAPM to the equity market in New Zealand however is potentially complicated by the characteristics of the New Zealand taxation system. Potentially, both the dividend imputation tax system and different rates of tax on interest and capital gains can affect the return on equity required by New Zealand residents.

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[35] There are a variety of forms the WACC could take under a system of dividend imputation. See Officer, R.R., "The Cost of Capital of a Company Under An Imputation Tax System", *Accounting and Finance*, 31,1, May 1994**.** Whatever the form of the WACC adopted, it is critical to ensure consistency with the other elements of TSLRIC. Specifically, whatever the form of the WACC adopted, it is important to ensure that company tax payments are modelled consistently.

[36] An alternative form of the vanilla WACC has no tax parameters. The form of vanilla WACC used by the Commission in the airfields decision reduces the cost of debt in the WACC by the factor (1-T) to reflect the tax deductibility of interest payments. This factor is often referred to as the tax debt shield.

234. Two major practical options for the Commission in estimating the required return on equity are the simplified Brennan-Lally CAPM and the standard CAPM. The simplified Brennan-Lally model was used by the Commission in the draft airfield activities decision. The standard CAPM is used by regulators in Australia and around the world.

235. Both approaches have their limitations. They involve simplifying assumptions which are highlighted below. Without pre-judging the most appropriate form of the CAPM, the Commission sees value in maintaining a consistent approach across its decisions.

Simplified Brennan-Lally CAPM

236. The simplified Brennan-Lally CAPM model adopted by the Commerce Commission in the draft airfield activities decision is defined as follows:

$$r_e = r_f\left(1 - t_{\text{int}}\right) + \beta_e\left(Post\,Tax\,Market\,Risk\,\text{Pr}\,emium\right)$$

where

r_e is the return on equity;

r_f is the risk free rate of return;

t_{int} is the weighted average effective tax rate on interest for all investors –

defined as the weighted average over investors of:

$$\frac{\left(T_{Ii} - T_{gi}\right)}{\left(1 - T_{gi}\right)}$$

where T_{Ii} is investor *i*'s marginal tax rate on interest income and T_{gi} is investor *i*'s marginal tax rate on capital gains;

β_e is the equity beta;[37] and

$$Post\ Tax\ Market\ Risk\ Premium = r_m - r_f\left(1 - t_{\text{int}}\right)$$

[37] The equity beta reflects the non-diversifiable risk associated with the asset and is defined as $\frac{Cov\left(r_e, r_m\right)}{Var\left(r_m\right)}$. Non-diversifiable or systematic risk refers to risks that apply to the market as a whole which cannot be eliminated by holding a diversified portfolio of assets, e.g. economic activity, inflation, tax rises, etc.

where

r_m is the expected level of return on the market portfolio of risky assets.[38]

237. The Brennan-Lally CAPM model builds on a CAPM model developed by Brennan in the United States. Brennan developed a CAPM model that captures the effects on the return to equity of differences in the (personal) tax rates on capital gains and dividends. Brennan's model was developed in the context of the "classical" tax system in the United States that does not include a dividend imputation tax system. Lally extended Brennan's model to capture the effects on the return to equity of dividend imputation.[39] That is, Lally's model allows for differences in (personal) tax rates on capital gains, dividends and interest income. In this respect, the model developed by Lally is consistent with the tax environment in New Zealand.

238. In the draft airfield activities decision, the Commission assumed that:

- investors face a 33% marginal tax rate on interest and that capital gains are not taxed and hence that the value of t_{int} is 33%; and
- dividend imputation credits are fully paid out by the firm and are fully utilised by the marginal investor.

Issues and assumptions

239. As the simplified Brennan-Lally CAPM captures the features of the New Zealand tax system, the Commission currently considers that it is most appropriate for determining the cost of capital. However, it must be recognised, that the model is based on a number of assumptions.

Domestic CAPM

240. The simplified Brennan-Lally CAPM is based on the assumption that the New Zealand capital market is segmented from the global capital market. That is, the cost of capital in New Zealand is determined by the rate of return required by New Zealand investors rather than international investors.

241. Although this assumption is tenuous, it is a property of CAPM models used by regulators in Australia and New Zealand. The alternative assumption (which is likely to be more accurate) is that the cost of capital is determined in integrated global capital markets. However, as there is no

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[38] The Brennan-Lally CAPM model is shown in Appendix 1.

[39] Lally, M. "The CAPM Under Dividend Imputation", *Pacific Accounting Review*, vol.4, December, 1992, pp.31-44.

accepted approach to estimating an international CAPM and as little work has been done on determining the appropriate parameters for such a CAPM (such as the expected return on the global market portfolio), it is common practice for regulators to use a domestic CAPM.

Value of dividend imputation

242. The simplified Brennan-Lally CAPM assumes that all available imputation credits are distributed and investors are able to fully utilise the distributed credits.[40] This again reflects the assumption that the New Zealand capital market is segmented from the international capital market. While the assumption of market segmentation is a strong one, it is consistent with the use of a domestic rather than an international CAPM.

243. Although this is the case, it should be noted that these assumptions will potentially have a significant effect on the cost of capital. For example, Lally indicates that dividend imputation can cause the cost of equity to rise or fall by up to 3.3%.[41]

Differential tax rates on dividends, interest and capital gains

244. As noted above, one of the key reasons for using the Brennan-Lally CAPM model is its ability to account for the effect on the return to equity of different (personal) tax rates on dividends, interest and capital gains.

245. Although different personal tax rates are applied on dividends and capital gains in the United States, it is noted that the Brennan CAPM model (which is designed to capture the effects of the difference on the return to equity) has not been widely adopted. Rather, the standard CAPM model (which is based on the assumption of no such differences) is the standard approach to estimating equity returns.

246. There are a number of possible reasons for this, including:

- investors can implement strategies which mean they pay the same effective tax rate on dividends and capital gains;[42] and

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[40] This means that the imputation credit utilisation factor (U) defined in the Brennan-Lally CAPM model is assumed to be equal to 1 and the term $t_{div} = 0$ (see Appendix 1). This results in the simplified version of the Brennan-Lally CAPM.

[41] Lally, M. *op.cit*.

[42] Miller and Scholes, "Dividends and Taxes", *Journal of Financial Economics*, 6, 1978, pp.333-364.

- the empirical evidence on whether higher-dividend paying stocks need to provide higher returns on average (due to a higher tax rate on dividends than capital gains) is mixed.[43]

Consistent definition of company tax liabilities

247. Regulators must ensure there is consistency between the definition of the cost of capital and other separate costs items, including the assumed company tax liabilities. If a Vanilla WACC (as defined in this paper) and a simplified Brennan-Lally CAPM is used to estimate the cost of capital, the company tax rate is simply defined as the assumed corporate tax rate, with no adjustments needed with regard to the tax deductibility of interest or the utilisation of imputation credits.

Standard CAPM

248. A major practical alternative to the simplified Brennan-Lally CAPM is the standard CAPM which is used widely in Australia[44] and throughout the world. The standard CAPM is defined as

$$r_e = r_f + \beta_e \left[Market\ Risk\ \Pr emium \right]$$

where

$$Market\ Risk\ \Pr emium = r_m - r_f$$

Issues and assumptions

Domestic CAPM

249. As with the simplified Brennan-Lally CAPM, the standard CAPM produces an estimate of the cost of equity where the capital market is defined as the New Zealand market, rather than the international capital market. As outlined above, in practice regulators use domestic versions of CAPM as these estimation approaches are more accepted and standardised and the parameter estimates can be more readily obtained.

[43] For example, see Miller and Scholes "Dividends and Taxes: Some Empirical Evidence", *Journal of Political Economy*, vol. 90, no. 6, 1982, pp. 1118-1141.

[44] Office of the Regulator General, *Electricity Distribution Price Determination 2001-2005: Volume I Statement of Purpose and Reasons*, September 2000, p.122-123; ACCC, *Draft Statement of Principles for the Regulation of Transmission Revenues*, May 1999, p.75.

Value of imputation

250. Unlike the simplified Brennan-Lally CAPM, the standard CAPM allows greater flexibility about the assumptions relating to the distribution and use of imputation credits. In particular, it is not necessary to assume that all credits are distributed and that all of these credits are fully utilised.

Same investor-level tax rates on interest and capital gains

251. Unlike the Brennan-Lally CAPM, the standard CAPM assumes that (personal) taxes on interest and capital gains are the same.

Consistent definition of company tax liabilities

252. As previously noted, regulators must ensure there is consistency between the definition of the cost of capital and other separate costs items, including the assumed company tax liabilities. If a Vanilla WACC (as defined in this paper) and a standard CAPM is used to estimate the cost of capital, the company tax rate is defined as:

$$T(1-\gamma)$$

where

γ is the proportion of company tax that can be rebated against personal tax due to dividend imputation and hence is really personal tax rather than company tax.[45]

253. No adjustment is needed for the tax deductibility of interest, as this is accounted for within the estimate of the cost of capital.

The Commission seeks comment on the appropriate form of the WACC and CAPM.

8.2. Other WACC issues

254. Having examined the approach to estimate a nominal post-tax WACC (which is always the starting point in any WACC calculation) [46], this section considers whether further conversions are appropriate to:

- express the WACC in a pre-tax rather than a post tax form; and/or

[45] Officer, R.R. *op. cit*

[46] A post tax WACC would always be estimated in the first instance as observable market based WACC parameters are post tax parameters.

- express the WACC in real rather than nominal dollar terms.

8.2.1. Pre- or post-tax WACC

255. Post-tax forms of the WACC assume company taxes are treated as a cost separate to the cost of capital. Pre-tax forms of WACC account for the cost of taxation directly in the WACC estimate and hence company tax liabilities are included in the return on capital. A pre-tax WACC will have a higher value than a post-tax WACC.

256. To estimate a pre-tax WACC, a single effective company tax rate must be defined. This is problematic as it is virtually impossible to estimate a single effective tax rate that will accurately reflect the firm's taxation liabilities, as the taxation liabilities will inevitably vary from year to year. In addition, there is no single accepted formula for converting a post-tax WACC to a pre-tax WACC (resulting in some controversy in previous regulatory determinations[47]) and a pre-tax WACC cannot be readily compared to capital market rates (usually express in after company-tax terms).

The Commission proposes to estimate a post-tax WACC and to provide for company taxation liabilities as a separate cost.

8.2.2. Real or nominal WACC

257. Regulators may choose to measure the post-tax WACC in real dollars as well as nominal dollars. A nominal WACC is expressed in current dollar terms and a real WACC is expressed in constant dollar terms. Hence, the real WACC shows the value of the WACC excluding the impact of inflation.

The Commission proposes to use a nominal post-tax WACC.

8.3. Risk-free rate

258. The risk free rate is the rate of return required by investors in order for them to willingly invest in a riskless asset. The risk free rate is almost always

[47] The difficulties associated with estimating a pre-tax WACC generated an enormous amount of debate in Australia during the regulatory price setting process that the ACCC and ORG undertook in 1988 in relation to the three gas distributors in Victoria (Multinet, Westar, Stratus). While the outcome of that process was that a real pre-tax WACC was used, the academic advisors to the parties (Professor Bob Officer, Professor Kevin Davis and Dr Neville Hathaway) all agreed that the best means of dealing with the tax liabilities of the regulated firms is to use a simple post-tax WACC formulation and to deal with tax as an item in the allowed revenues. At that time, the ORG undertook to assess this issue further in subsequent regulatory hearings. As a result of its further deliberations, the ORG has now chosen to implement a vanilla nominal post-tax WACC, and to address the cost of taxation to the regulated firms in the annual allowed revenues. The ACCC also uses a post-tax WACC.

measured by the return on government bonds (as government bonds are considered to be almost free of risk). There are two major issues in determining the risk-free rate. One is the maturity of government bonds to use. The second is whether to average government bond rates around the date of setting the WACC.

8.3.1. Appropriate maturity

259. The CAPM is a single period model of fixed duration. Hence it provides little or no guidance as to the appropriate maturity of government bonds to use for the risk-free rate. Typically regulators have adopted one of three alternatives in determining the appropriate maturity of government bonds. One is to base the maturity on the lifetime of the assets used in providing the regulated service. This reflects the planning horizon of investors in those assets. Another is to base the maturity on the duration of the Commission's determination. This is based on the recognition that the risk-free rate will be adjusted in any subsequent determination. A third approach is to use the bond term used to measure the market risk premium. This ensures consistency within the CAPM.

Lifetime of the assets used to provide the regulated service

260. Investors in long-lived assets consider returns over the economic life of those assets. In determining whether to invest, investors will compare these expected returns to the opportunity cost of making the investment. That opportunity cost is the returns investors could achieve in the market based on a similar commitment of funds (in terms of risk and duration). For example, a government bond of similar duration. This implies that the appropriate maturity of government bonds should be similar to the economic life of the assets.

Duration of the Commission's determination

261. The major argument for basing the maturity of government bonds on the duration of the Commission's determination is that it can act to reduce interest rate risk faced by the company. In the event that the Commission is required to determine interconnection charges on an on-going basis, setting charges for the period of the determination allows for the risk-free rate to be adjusted at that time.[48] This reduces the interest rate risk associated with long-term investments in fixed PSTN assets.

Bond rate used to estimate the market risk premium

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[48] Of course, there is no reason to believe that the Commission will be involved in determining charges in future periods. However, it can be expected that parties will negotiate with the approach adopted by the Commission in previous determinations in mind.

262. The market risk premium measures a margin over the risk-free rate necessary in order to encourage investors to hold the market portfolio. This margin is typically estimated relative to a risk-free rate based on the yield of 10-year government bonds. To ensure an internally consistent CAPM, the risk-free rate should be based on the government bonds with the same maturity as that used to estimate the market risk premium.

263. The Commission in the draft airfield activities decision used a government bond rate with a maturity aligned with the regulatory period, i.e. the price setting period to determine the risk free rate.

The Commission seeks comment on the appropriate government bond maturity for determining the risk-free rate.

8.3.2. Averaging of rates

264. It is common practice among regulators to average government bond rates around the time the WACC is set. There are two potential justifications for this. One potential justification is that it better reflects the opportunity cost of the funds of the investor. The second is that it reduces the possibility of "rate shocks".

265. The first potential justification has no theoretical basis. The most recent observation of the risk-free rate represents the opportunity cost of investors' funds. It contains all available information concerning expected changes in the opportunity costs over the life of the bond.

266. The second potential justification has some merit. Averaging rates reduces the uncertainty concerning future regulated returns.

267. In its draft airfield activities decision, the Commission recommended using a six-month average of the daily bond rate.

The Commission seeks comment on the appropriate averaging of the government bond rate in determining the risk-free rate.

8.4. Market risk premium

268. The market risk premium (MRP) measures the premium over the risk free rate that investors expect to earn on the market portfolio.

269. Under a standard CAPM model the market risk premium (MRP) is defined as $r_m - r_f$ which is the difference between the expected level of return on the market portfolio (r_m) and the risk free rate of return (r_f).

270. Under the simplified Brennan-Lally CAPM the market risk premium is defined in post-tax terms. The Post Tax Market Risk Premium (PTMRP) is

defined as $r_m - r_f(1 - t_{\text{int}})$. The PTMRP measures the premium that investors expect to earn on the market portfolio over the tax adjusted risk free rate.

271. Assuming the Commission decides to adopted the simplified Brennan-Lally CAPM (as in the draft airfield activities decision), it has two main avenues to determine the appropriate value of the PTMRP. The first is to review the available studies undertaken in New Zealand to estimate the PTMRP. The second is to use estimates of the market risk premium in other markets.

272. A sample of the studies undertaken in New Zealand to estimate the PTMRP under the Brennan-Lally CAPM model and their results are shown in Table 4.

Table 4: Review of PTMRP estimates

Author	Approach	Result
NZ Treasury [1]	Arithmetic averaging of ex-post annual counterparts of each term of the CAPM - using New Zealand data from 1958 onwards	PTMRP = 9%
PriceWaterhouseCoopers	Arithmetic averaging of ex-post annual counterparts of each term of the CAPM - using New Zealand data from 1925 onwards [2]	PTMRP = 8%
	- using New Zealand data from 1956 onwards	PTMRP = 9%
Credit Suisse First Boston	Estimation of relationship between MRP and market volatility (i.e. market variance or standard deviation)	PTMRP = 7.5%
Lally	Estimation of expected return on market portfolio using current market dividend yields and estimated dividend growth rates	PTMRP = 7.1% to 8.9%

Sources: New Zealand Treasury, *Estimating the Cost of Capital for Crown Entities and State-Owned Enterprises*, 1997, p.46; Lally, M., *The Cost of Capital for the Airfield Activities of New Zealand's International Airports*, June 2001, p.9 and PriceWaterhouseCoopers, *New Zealand Equity Market Risk Premium*, March 2000.

Notes:

1. The Treasury indicates that there is considerable statistical uncertainty about the 9% estimate – a 95% confidence interval on the estimate of ±7%.
2. Lally estimates a 95% confidence interval on the PWC 8% estimate of ±5%.

273. Although the market risk premium is intended to be a forward-looking measure, many studies are based on historical market outcomes. While these studies provide useful information, current analysis indicates that the forward-looking market risk premium may be below the level given by

historical averages. Hence, the Commission sees value in seeking forward-looking estimates.

274. In the draft airfield activities decision, the Commission considered that the best estimate at the time of the PTMRP was 8%. However, the Commission considers that additional analysis could usefully be undertaken to improve the robustness of the PTMRP estimates for New Zealand.

275. A second approach the Commission can use to estimate the value of the PTMRP is on the basis of estimates of the market risk premium (MRP) under a conventional CAPM model, both for New Zealand and for other markets.

276. Based on the simplified Brennan-Lally CAPM, the PTMRP measure can be converted to a standard MRP as follows:

$$MRP = PTMRP - (r_f * T)\text{; or}$$

$$PTMRP = MRP + (r_f * T)$$

where T is the marginal personal tax rate on interest income, which is equal to 33% in New Zealand.[49]

277. Hence, the current estimate of the PTMRP of 8% is equivalent to a 5.7% MRP under standard CAPM (based on a risk-free rate of 6.9%).

278. PriceWaterhouseCoopers has estimated a MRP for New Zealand based on the data it used for its PTMRP study. This produced an MRP estimate in the range of 5% to 6%.[50] Chay, Marsden and Stubbs produced a historical MRP estimate of 6.49% for the period 1931 to 1994.[51]

279. In making comparisons with MRP estimates for other markets, the Commission is of the view it would be most useful to make comparisons with other markets that are similar to New Zealand, i.e. small, open economies such as Australia. However, care must be taken as market risk can differ across countries.

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[49] New Zealand Treasury, *Estimating the Cost of Capital for Crown Entities and State-Owned Enterprises*, 1997p.47 and Lally, M., *The Cost of Capital for the Airfield Activities of New Zealand's International Airports*, June 2001, p.9.

[50] PriceWaterhouseCoopers, *New Zealand Equity Market Risk Premium*, March 2000, p.6.

[51] Chay, J., Marsden, A. and Stubbs, R., "Investment returns in the New Zealand market: 1931-1994, *New Zealand Investment Analyst*, 16, 1995,pp. 19-27.

280. A more substantial literature on the value of the MRP for Australia is available than currently exists for New Zealand.[52] Based on this literature, the ACCC and the ORG are currently of the view that the MRP for Australia is 6%.

The Commission seeks comment on the appropriate approach for refining its estimates of the New Zealand PTMRP.

8.5. Equity beta (systematic risk)

281. The equity beta reflects the expected systematic risk of a security, i.e., the expected sensitivity or volatility of a particular security relative to the market as a whole.[53] The systematic risk or equity beta assumed by the Commission can have significant effects on the cost of equity.

282. Unfortunately, in most cases, there is no 'first best' approach to estimating the equity beta for the purposes of determining regulated prices. As a result, it is typical for regulators to 'shed light' on the appropriate equity beta from a range of information and estimates. Estimating the appropriate equity beta for investments in fixed PSTNs is no different.

283. The Commission considers that information from a range of sources may assist in determining the appropriate equity beta for investments in fixed PSTNs. They are:

- direct estimation of equity betas from market data; and
- equity betas of comparable companies in New Zealand or other countries.

284. As noted below, each of these approaches have their advantages and disadvantages. As a result, they can best be thought as determining a range within which the equity beta lies.

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[52] Some relevant studies include: Kortian, T, *Australian Share Market Valuation and the Equity Premium*, Department of Finance, University of Sydney, September 1998, Officer, R.R., "Rates of Return to Shares, Bond Yields, and Inflation Rates: An Historical Perspective," Chapter 14 in Ray Ball, Philip Brown, Frank Finn, and Robert Officer, eds. "Share Markets and Portfolio Theory: Readings and Australian Evidence", University of Queensland Press, St. Lucia, 1989, 207-211.; Ibbotson Associates, *International Equity Risk Premia Report*; 1999, Professor Keith Davis, *The Weighted Average Cost of Capital for the Gas Industry*, Report prepared for the Commission and the Office of the Regulator General, 1998.

[53] Systematic or non-diversifiable risk refers to risks that apply to the market as a whole which cannot be eliminated by holding a diverse portfolio of assets, e.g. economic activity, inflation, tax rises, etc. A security with a beta of 1 it has average market risk, a security with a beta < 1 has below average market risk, and a security with a beta >1 has above average market risk.

285. Whatever the equity beta decided upon, the Commission will endeavour to, as a sanity check, cross-check the equity beta with that used in previous regulatory decisions, such as the Commission's draft airfield activities decision. Although it is unlikely that the equity betas should be the same, the direction and size of the differences should be explainable.

8.5.1. Direct estimation of equity betas from market data

286. For a publicly listed company, it may be possible to estimate the expected company beta based on historical data, i.e., comparing the past share price to past market movements. Data exists to estimate the equity beta for Telecom.[54]

287. Care must be taken in adopting this approach. Three issues are likely to be particularly relevant. These can best be demonstrated by reference to Telecom as the access provider.

288. First, the equity beta for Telecom reflects the systematic risk on investments in Telecom as a whole, rather than investments in the assets used to provide fixed PSTN services (including interconnection services). An investor in Telecom invests in a business providing a broad range of communications and telephony services, including mobile telephony services, data and internet services, as well as investments in other countries (such as AAPT in Australia). The required expected return on that investment is an average of the required rates of return across all these investments. This is likely to differ to the required return on assets to provide fixed PSTN services.

289. Whether or not the equity beta for Telecom as a whole is larger or smaller than the equity beta for investments in Telecom's fixed PSTN will depend on a range of factors including the demand and costs characteristics of the other services provided by Telecom relative to fixed PSTN services.[55]

290. Second, it is possible that Telecom's (or any access provider's) equity beta may differ from that of an efficient provider as a result of the manner in which it structures its finances for instance.

291. Third, there is likely to be a (significant) degree of error in an estimate of the equity beta for a single firm. The precision with which the equity beta is estimated will likely increase if a larger sample of firms is used.

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[54] Estimates of the equity beta on the basis of historical data are likely to reflect forward-looking systematic risk so long as there have been no major changes in either the structure of Telecom or its gearing over this time.

[55] For instance, the variability of demand over the business cycle, the extent to which costs are fixed, etc.

The Commission seeks comments on the use of an estimate of access provider's equity beta from market data as a benchmark for the equity beta for assets used to provide fixed PSTN services.

8.5.2. Equity betas of comparable companies in New Zealand or other countries

292. A second source of information upon which to determine an appropriate equity beta is the equity betas of companies with similar systematic risk. These companies could be in New Zealand or other countries. In undertaking such an exercise it is important, to the extent possible, that the comparisons be 'like-for-like'. A number of factors and characteristics of firms affect their systematic risk.

293. *Sensitivity of revenues to real GNP shocks:* One factor affecting systematic risk is the sensitivity of the firm's revenues to real GNP shocks. In turn this is likely to be affected by, among other factors, the sensitivity of the demand for the firm's products to changes in income. All else the same, the greater the sensitivity the greater the systematic risk. Ideally, comparable firms should provide similar services. In this case fixed PSTN services.

294. *Operating leverage:* Operating leverage refers to the ratio of fixed to total operating costs. The returns of firms with relatively higher operating leverage will be relatively more sensitive to real GNP shocks, suggesting a relatively higher beta. Ideally, comparable firms should have a similar operating leverage (such as firms providing fixed PSTN services).

295. *Financial leverage*: The financial leverage of a company is the extent to which the company is funded through debt. In general, the higher the financial leverage of the company, the higher the company's equity beta. As debt holders have a fixed contractual claim on the cashflows of the company, the higher the company's financial leverage, the greater the sensitivity of the equity returns to the market returns.

296. *Duration of contracts:* The returns of firms with contracts with customers and suppliers of a longer duration should be less sensitive to real GNP shocks, and hence have a lower beta. Most consumers can purchase fixed PSTN services (such as national toll calls) on a variable basis.

297. *Regulatory environment*: Another factor that is likely to affect systematic risk is the regulatory environment within which the firm operates. For example, if the regulatory environment limits the pricing flexibility of the firm, its returns, all else the same, are likely to more sensitive to real GNP shocks than firms without such regulation.

298. *Differences in market risk:* Systematic risk is measured relative to the market portfolio. The equity betas of two firms with the same systematic risk

may not be comparable unless the market risks against which the equity betas are measured are the same.

299. Some of these differences can potentially be adjusted for (such as financial leverage). In other cases it is necessary to select companies with demand, cost and market characteristics that are similar.

Comparable companies in New Zealand

300. Possible benchmarks for fixed PSTNs are utilities, such as electricity and gas companies. These utilities have a number of similar characteristics to fixed PSTN (particularly Telecom's fixed PSTN). First the demands for electricity, gas and telephony services are similar insofar as their use is ubiquitous and their income elasticities of demand are small. Second, the characteristics of the costs of providing these services are similar, involving a high proportion of relatively fixed costs. As noted below, it would be necessary to adjust the betas for differences in the gearing of the utilities and Telecom's fixed PSTN.

301. The major difficulty with this approach is whether utilities are sufficiently similar to provide useful benchmarks. On the other hand however, as the equity betas of utilities in New Zealand are measured relative to the market risk in New Zealand, they may provide more useful benchmarks for Telecom's fixed PSTN than more similar (telecommunications) companies in other countries.

The Commission seeks comments on the use of utilities in New Zealand as benchmarks for determining the appropriate equity beta for investments in fixed PSTNs. The Commission is particularly interested in which utilities are likely to provide the most appropriate benchmarks.

Comparable companies in other countries

302. One set of international benchmarks for Telecom's fixed PSTN are the Regional Bell Operating Companies (RBOCs) and major interstate telecommunications network operators (such as AT&T) in the United States. There are a few reasons for this. First, their primary (and nearly sole) activity is to provide fixed PSTN services similar to those provide by Telecom. Second, the cost characteristics of the companies are similar. Third, they face somewhat similar regulatory environments.

303. One problem with limiting the sample of benchmark companies to RBOCs and AT&T is the sample size. As noted above, the estimate of the equity beta for an individual company is subject to error. Increasing the sample size to include companies in other countries that primarily (mostly) provide fixed PSTN services can reduce this error.

304. Having identified appropriate comparator firms in other countries, it is necessary to adjust estimates of the equity betas for these firms to ensure that 'like-for-like' comparisons are made with Telecom's fixed PSTN.

305. Two key adjustments that must be made relate to differences in market risk faced by the comparator firms and the financial leverage of the comparator firms, relative to Telecom's fixed PSTN services.

Differences in market risk

306. The equity betas of international firms relate to the market in which they operate. For instance, the 'market' against which the volatility of the stock is measured is the market in that country, e.g. equity betas for US stocks can be measured relative to the S&P 500 Index, NZ stocks can be measured relative to the NZ SE 40. The relative risks of the market portfolios that these indices reflect could be very different. For example, the US market reflects technology stocks more predominately than the New Zealand market. The difference in the relative market risk faced by firms in different countries is likely to be the most significant source of difference between equity beta estimates across countries. Adjustments should be made. This involves determining the correlation between the market returns across countries and adjusting the betas of international firms accordingly.

Differences in financial leverage

307. The systematic risk of a security as measured by the equity beta will reflect a firm's financial leverage. Therefore, when making comparisons across firms the effect of leverage is typically removed (i.e. an estmate of the beta is produced assuming the firm has no debt) by converting an equity beta to an asset beta. This is referred to as de-levering. The asset beta is then estimated for the regulated firm and the asset beta is re-levered based on the access provider's financial structure to obtain an estimate of its equity beta.

308. There are a large number of methodologies that can be used for de-levering and re-levering. This has been an area of some controversy in recent regulatory hearings in Australia.

309. In principle, the de-levering and re-levering approach used must be consistent with:

- *the tax environment of the market the firms operate in:* For example, if the market in which the overseas comparator firm operates does not have a dividend imputation tax system (e.g. USA), then it would be inappropriate to use a de-levering approach such the Monkhouse approach that incorporates the impact of dividend imputation;
- *the approach that is used to estimate the cost of capital and cost of equity:* For example, if a simplified Brennan-Lally CAPM is used, then the re-

levering approach used must be consistent with this form of CAPM; and

- *the assumptions concerning the cost of debt faced by the firm:* If it is assumed that the cost of debt is the same as the risk-free rate, then a relatively simple re-levering formula can be used.

The Commission seeks comment on:

- the choice of comparable companies in overseas market for the purposes of determining an appropriate equity beta; and
- issues in adjusting the equity beta of comparable companies in overseas markets.

The Commission is particularly interested in solutions to difficulties in adjusting equity betas for differences in market risk.

8.5.3. Consistency with previous decisions

310. The two approaches outlined above can potentially provide the Commission with useful empirical evidence on the appropriate equity beta for investments in fixed PSTN services. Whatever the equity beta decided upon however, the Commission will endeavour to, as a sanity check, cross-check the equity beta with that used in previous regulatory decisions. Although it is unlikely that the equity betas should be the same, the direction and size of the differences should be explainable. The aim in doing so, to the extent possible, is to ensure regulatory consistency.

311. There are two issues for the Commission. First is whether the access provider should have a higher or lower equity beta. Second is by how much. In assessing this, the Commission will consider the factors that effect the equity beta of a firm listed above.

8.6. Cost of debt

312. The WACC estimates the weighted average cost of debt and equity, with the weights determined by the relative share of debt and equity in the firms' capital structure. The cost of debt (r_d) is typically measured as the risk free rate of interest plus a debt risk premium. This section examines the methods of estimating the debt risk premium.

313. As with the cost of equity, the estimate is intended to be forward looking, i.e. to estimate the expected cost of debt in providing fixed PSTN services into the future.

314. There are two approaches that regulators typically use to estimate the debt risk premium:

- direct observation of the access provider's actual cost of debt, e.g., via the yield on debt issued by the access provider; or

- estimation of a benchmark debt margin for a firm with a similar credit risk and capital structure.

315. When applying either of these approaches, it is necessary to ensure consistency with assumptions used in other elements of the WACC formulation including:

- the debt premium should be consistent with the risk free rate, e.g., if a ten-year government bond rate is used as the risk free rate then publicly traded debt securities that are used to determine the debt premium should have the same or similar maturity; and

- the debt premium should be consistent with the assumptions made about the access provider's capital structure and credit rating. The lower the level of gearing and better its credit rating, the lower the debt premium a firm would be required to pay to attract debt investors[56].

8.6.1. Direct observation

316. Other regulators, including the ACCC, have used this approach. For example, in its report on Telstra's PSTN services, the ACCC[57]:

> believed that the debt premium observed in the market for Telstra bonds gave the best measure of the premium required by investors, as it would be based on their assessment of Telstra's credit rating.

317. However, if the yield on the access provider's debt securities is used, this value would require adjustment so it relates only to fixed PSTN services. For example, in the case above, the ACCC made a downward adjustment for the fact that the debt premium related to Telstra as a whole, rather than its PSTN business.

8.6.2. Benchmarking

318. The benchmarking approach seeks to determine the debt margin on the basis of 'similar' firms observed in the market.

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[56] ACCC, *A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services*, 2000, p.92.

[57] *ibid*.

319. In the draft airfield activities decision, the Commission based the debt premium on debt margins of firms with a similar credit risk and capital structure.

The Commission seeks comment on the appropriate approach to estimate the debt risk premium.

8.7. Gearing

320. Gearing refers to the firm's proportions of debt and equity. A highly geared firm has a high ratio of debt to equity. The gearing ratio affects two parts of the WACC. One part are the weights applied to the costs of debt and equity to obtain the overall cost of capital. The second is the effect it has on the cost of equity. As noted above, the lower the proportion of debt to equity the lower the systematic risk of investing in the firm and lower the cost of equity.

321. This section examines the following approaches to determining the debt to equity ratio:

- the current ratio measured on the basis of book values;
- the current ratio measured on the basis of market values;
- the target ratio; or
- an estimate of the optimal (cost minimising) ratio – based on benchmarks.

322. *Book value*: This approach uses the gearing ratio based on the accounting value of the firm's debt and equity.

323. *Market value*: This approach is based on the observed market value of the firm's debt and equity.

324. *Target ratio:* This approach uses the firm's target gearing ratio.

325. *Optimal ratio*: This approach is based on an optimal gearing ratio. This is far from straightforward and would need to consider any tax advantages associated with debt weighed against the bankruptcy risk that debt creates.

326. A number of issues are relevant in deciding between the approaches to setting the gearing level.

Book or market values

327. Ideally the level of gearing should be consistent with the expectations of debt and equity holders in investing in the asset. That is both debt and equity investors perceive a level of risk in committing funds to the firm. The

higher the gearing the greater the risk perceived by both debt and equity holders and the higher the rate of return they require. As it is likely that at any point of time the market value of the firm's equity will differ from the book value, gearing levels based on the accounting value of the firm's debt and equity are unlikely to be appropriate.

Target or current market values

328. A second issue is whether the Commission should use the access provider's current market gearing level or its target level (assuming they differ). Target gearing levels (assuming they are 'believed' by the market) are likely to be reflected in the cost of debt and equity. For instance, purchases of the firm's bonds are likely to consider the gearing level over the maturity of the bond in deciding whether to invest.

Benchmark values

329. One problem with using market or target gearing levels is that they reflect the gearing of the access provider as a whole and may not reflect the efficient funding of a firm providing only fixed PSTN services. That is the WACC based on the gearing for the access provider as a whole may not reflect the opportunity cost of the funds to invest in assets to provide fixed PSTN services. Yet this is what is relevant in the estimation TSLRIC.

330. One approach to estimating the efficient gearing levels is on the basis of gearing levels of other telecommunications companies or utilities. As there will no doubt be differences in the characteristics of the firms, such benchmarks are at best likely to produce a range within which the efficient gearing level of a fixed PSTN business is likely to lie.

Sensitivity of the WACC to changes in the level of gearing

331. At the margin, the level of gearing should have little or no effect on the WACC. An increase in the debt to equity ratio has two effects. One is to shift funding toward debt which reduces the WACC (as debt is funded at a lower rate). The other is to increase both the cost of debt and equity which increases the WACC. As a result, differences in the gearing level over a range may only have a marginal effect on the WACC. Given the difficulties in determining an appropriate gearing level, it may be advisable to 'test' the effects of differing gearing levels within a range.

The Commission seeks comment on the appropriate approach to determining the gearing level.

8.8. Corporate tax rate

332. There are two options to defining the corporate tax rate. One is to use the statutory company tax rate, which is currently set at 33%. The other is to

use an estimate of the effective tax rate, which reflects a long run average tax paid over the life of the assets. In some circumstances the effective tax rate will differ from the corporate tax rate

333. One source of differences between the statutory tax rate and the effective tax rate is tax shields such as accelerated depreciation on capital expenditure and the tax deductibility of debt.

334. While the statutory tax rate is easily observable, the effective tax rate (which would need to estimated through modelling) may provide a more accurate estimate of tax paid (and hence costs incurred). It is noted that estimating an effective tax rate will require that assumptions be made about future inflation, capital expenditure and interest costs.

335. In the draft airfield activities decision, the Commission adopted the statutory tax rate.

The Commission seeks comment on the appropriate corporate tax rate.

8.9. Value of dividend imputation credits

336. A full dividend imputation tax system operates in New Zealand. How dividend imputation is treated depends on whether the Commission employs a simplified Brennan-Lally CAPM or a standard CAPM.

337. Under a simplified Brennan-Lally CAPM the effects of dividend imputation are captured in the cost of equity (r_e). As discussed previously this model assumes that all dividend imputation credits are distributed and fully utilised and hence that the value of the dividend utilisation factor is 1.

338. If a standard CAPM is used, the effects of dividend imputation are captured by adjusting the firm's taxation liabilities by $(1-\gamma)$ where γ (or gamma) is the imputation factor, which represents the proportion of company tax that can be rebated against personal tax due to dividend imputation.[58]

339. In the event that a standard CAPM is used, this section reviews available empirical studies of the value of γ which have been undertaken for the Australian market, which also has a full dividend imputation tax system. These studies provide estimates for average Australian investors, as well as estimates for large Australian companies with significant foreign investors. To the extent that Australia and New Zealand are both small, open

[58] Officer, R.R. "The Cost of Capital of a Company Under An Imputation Tax System", *Accounting and Finance*, 31,1, May 1994, p. 4.

economies, and the operation of the dividend imputation scheme is the same in both countries, the studies provide useful information to determine an appropriate estimate of γ for the New Zealand market. This section also reviews the γ values that have been used by regulators in Australia.

340. The value of the imputation factor, γ, can range between 0 and 1 and is a function of the extent to which:

- imputation credits are distributed by firms; and
- shareholders are able to utilise the distributed imputation credits.[59]

8.9.1. Empirical studies

341. Table 5 shows a selection of empirical studies by Australian academics.

Table 5: Empirical estimates of gamma

Author(s)	Estimated gamma (γ)
Cannavan, Finn & Gray	Close to 0 [1]
Walker and Partington	0.88 to 0.96 [2]
Officer and Hathaway	0.48
Bruckner, Dews and White	0.68
Brown and Clarke	0.72

Notes:
1 Marginal investor is an overseas investor. Domestic investors will invest first as they are able to utilise dividend imputation credits as well as receiving cash dividends and capital gains, whereas the overseas investor is unable to utilise the imputation credits.
2 0.88 for events and 0.96 for trades on average.

Sources:
Cannavan, D., Finn, F. and Gray, S., *The Value of Dividend Imputation Tax Credits*, Working Paper, Department of Commerce, University of Queensland, November 2000.
Walker & Partington, "The Value of Dividends: Evidence from Cum-Dividend trading in the Ex-Dividend Period", *Accounting and Finance,* Vol 39, No 3, 1999, pp. 275-296.
Hathaway, N.J. and Officer, R.R., *The Value of Imputation Tax Credits*, Working Paper, Revised and Extended, Graduate School of Management, Melbourne University, 1996.
Bruckner, K., Dews, N. & White, D., *Capturing Value for Dividend Imputation,* McKinsey and Company, Sydney, 1994.
Brown & Clarke "The Ex-Dividend Day Behaviour of Australian Share Prices before and after Imputation", *Australian Journal of Management,* Vol 18, 1993, pp. 1-40.

[59] If all available imputation credits are issued and shareholders are able to fully utilise the imputation tax credits then γ is equal to 1. If some imputation credits are withheld and/or shareholders are not able to fully utilise the imputation tax credits then γ would be < 1.

342. Clearly these studies provide a very wide range of estimates of the value of γ.

343. Issues of debate in relation to the methodologies used in these studies include:

- whether the utilisation factor should be based on the average investor or the marginal investor; and
- whether estimates of the utilisation factor should assume that the capital market is completely segregated, and hence that there are only domestic investors, in order to be consistent with CAPM estimation approach.

344. It should also be recognised that the studies have some limitations and hence the estimated values of γ should not be treated as exact. Limitations include:

- methodological constraints and econometric problems;
- lack of data; and
- wide confidence intervals for estimates.[60]

8.9.2. Regulatory decisions

345. The table below reviews the values of γ used by Australian regulators.

Table 6: Gamma assumed by regulators in Australia

Regulator	Determination	Gamma (γ)
ORG	Electricity Distribution Price Determination 2001-2005	0.5
ACCC	Telstra's Undertaking for the Domestic PSTN	0.5
ACCC	Draft Statement of Principles for Regulation of Transmission Revenues	0.5 – 0.9 (closer to 0.9) [1]
IPART	Electricity Distribution Price Determination	0.3 – 0.5
ACCC/ORG	Access Arrangements for Multnet, Westar and Stratus (Gas Distribution)	0.5

Notes:
1 Based on an assumption of private Australian ownership.
Sources:

[60] Cannavan, D., Finn, F. and Gray, S., *The Value of Imputation Tax Credits*, Working Paper, Department of Commerce, University of Queensland, November 2000, p.28

Office of the Regulator General, *Electricity Distribution Price Determination 2001-2005 Volume 1 Statement of Purpose and Reasons*, September, 2000, p.317.
ACCC, *A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services*, July, 2000, p. 88.
ACCC, *Draft Statement of Principles for the Regulation of Transmission Revenues*, May 1999, p.82.
Independent Pricing and Regulatory Tribunal, *Regulation of New South Wales Electricity Distribution Networks Determination and Rules Under the National Electricity Code*, December 1999, p. 45.
ORG, Access Arrangements for Multinet, Westar and Stratus, October 1998, p. 207.

8.10. Asymmetric risks

346. The CAPM determines the rate of return required by equity investors to compensate for the non-diversifiable or systematic risks associated with investment in the firm. The CAPM is based on a number of assumptions including that the distribution of returns to the investment are symmetrical.[61] However, under regulation, the returns may not be symmetric. By capping returns, regulation can reduce the expected returns on investments to below a commercial return. In turn, this is likely to inefficiently discourage future investment in regulated assets (such as by access providers in their fixed PSTN).

347. Although the concept of asymmetric risk and its conceptual relevance to the determination of regulated prices (including interconnection charges) is well recognised, there are differing views on the source(s) of the asymmetric risk, the practical relevance of the risk in determining interconnection charges and how the risk should be measured.[62]

8.10.1. Possible sources and practical relevance of asymmetric risk

348. Asymmetric risks under regulation result from two key characteristics of investments in telecommunications infrastructure. First, investments in (some) telecommunications infrastructure are long-lived and irreversible. That is, once the decision has been made to invest in the infrastructure, the investments cannot be reversed (i.e. the investor cannot 'undo' the investment by selling the asset for alternative use and recover the investment cost). An example of such an irreversible investment may be optical fibre cable in the core network. Second, investments in telecommunications infrastructure are made under uncertainty. This uncertainty stems from a number of sources including demand uncertainty and uncertainty surrounding technological

[61] Specifically, it is assumed that the distribution of returns are normally distributed.

[62] For example, see Alleman, J.& Noam (eds.), *The New Investment Theory of Real options and its Implication for Telecommunications Economics*, Kluwer Academic Publishers, 1999 for a number of papers from a conference where the issues were discussed in detail.

change. For example, when investing in transmission links in the core network, there is uncertainty as to future developments in technology that may result in the investment being obsolete or of lower value.

349. Two of the major potential sources of asymmetric risk under regulation are discussed below.

Truncated returns

350. One potential source of asymmetric risk is the prospect that determining interconnection prices on the basis of cost may create a profile of returns for the access provider that is lop-sided.[63] Interconnection prices based on TSLRIC enable the access provider to achieve a normal commercial return in most circumstances. However, there are potentially circumstances or events where the price will not enable the access provider to achieve such a return.

351. Under the approach to implementing TSLRIC detailed in Chapter 5, the core network is dimensioned to provide for current and forecast demand. Periodically, the network model will be re-optimised based on revised demand forecasts and on current best-in-use technology. This will involve changing the values of the assets and possibly removing some assets from the asset base. The issue is whether access providers will be able to recover the change in the value of the asset base as a result of the re-optimisation.

352. Take an example. Consider the costs of an asset (such as a inter-nodal link) that is removed from the asset base at a subsequent re-optimisation. This could result from a fall in demand that results in the link becoming unnecessary. The asset becomes stranded. Although the link may only be a few years old it no longer has a useful economic life. The issue is does the TSLRIC pricing methodology provide the access provider with an expectation at the time of the investment that the cost of the link will be recovered.

353. The answer to this depends on at least three factors. The first is how TSLRIC is implemented. The second is the nature of the shock that stranded the asset in the first instance. The third is the duration of the contract to purchase interconnection services.

354. Factors may be built into TSLRIC cost modelling may offset some (but not all) of the downside risks of the stranding of assets. One factor is how asset lives are determined. As noted in Chapter 7, asset lives can be determined based on their physical (engineering) lives or their economic lives.

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[63] See Hausman, J., 'The Effect of Sunk Costs in Telecommunications Regulation', in Alleman, J.& Noam (eds.), *The New Investment Theory of Real options and its Implication for Telecommunications Economics*, Kluwer Academic Publishers, 1999.

If they are based on the physical lives, there is no offsetting factor for stranded assets. If an asset does not last its full physical life, the costs will be under recovered. If they are based on their economic life (and hence adjusted to reflect the risk of stranding) however, there is an offsetting upside. Although some assets may have an actual life less than the expected life at the time of investment, others may have an actual life that exceeds the expected life. The costs of some assets will be under-recovered and the costs of others over-recovered.

355. Although TSLRIC modelling may provide for factors to offset the risk of the stranding of individual or groups of assets, it may not provide for shocks that result in permanent and significant reductions in the demand for fixed PSTN services as a whole. Although such events may be unlikely, there is some risk that large parts of an access provider's fixed PSTN may be made obsolete before the end of the economic lives of the assets. The prospect of such a shock may generate asymmetric risks which should be compensated for in interconnection charges.

356. A third factor is the duration of contracts to provide interconnection services. To the extent there are risks of asset stranding, who bears the risks (the access provider or access seeker) will depend on, among other factors, the duration of the contract to purchase interconnection services. In turn this will depend on the duration of the Commission's determinations. If the access seeker commits to purchase a particular volume of interconnection minutes for an extended period, some risk is transferred to the access seeker from the access provider. Of course, not all risk will be transferred. The point however is that any adjustment for asymmetric risk will depend on the duration of the contract between the access provider and access seeker.

Option to delay investment

357. A second potential source of asymmetric risk is that the obligation to provide interconnection services removes the option for access providers to delay investment in their fixed PSTNs. If this option has a value, the costs of foregoing the option is a cost that should be reflected in interconnection prices.

358. This logic has its roots in the real options theory of investment.[64] The real options theory states where:

- investments are made under uncertainty;
- some uncertainty is resolved through time;

[64] Dixit, A.K. and Pindyck, R.S., *Investment under Uncertainty*, Princeton University Press, 1994.

- it is costly or not possible to reverse investments; and
- investors have flexibility over the timing of their investments

it may be socially optimal to delay investment even if the net present value of the investment today is positive. For example, if an irreversible investment in telecommunications network infrastructure is made today and demand for the services that can be provided using the network is lower than expected, then the benefits from the investment (the value that end-users place on the services provided by the network) may be less than the costs of the investment. From a social perspective, it may be advisable to delay the investment until demand is less uncertain.

359. Arguably, if the obligation to provide interconnection services created by the Act imposes additional costs on access providers then those costs should be included in TSLRIC. A number of issues should be considered in assessing the practical relevance of these costs to interconnection prices.

360. First is whether these costs are imposed by the obligation to provide interconnection services. That is whether providing interconnection services increases the demand for the use of (and hence investment in) the access provider's fixed PSTN. For example. Baumol[65] argues that in the case of toll bypass, the obligation to provide interconnection services, although shifting market shares between the access provider and toll bypass operators, imposes little additional demand on the access provider's network.

361. Second is to consider the uncertainty that is resolved over time that gives rise to the value of the option to delay the investment. Typically, this is considered to be uncertainty associated with demand or technological change.

362. Third is to consider whether there are any offsetting options that additional investment creates that would be foregone or delayed but for the investment. An example may be the introduction of a new service or technology that would not have been possible or possible within a short time frame but for the investment.

363. Fourth is whether the opportunity to delay investment is an artefact of market power.

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[65] Baumol, W.J., 'Option Value and Analysis and Telephone Access Charges', in J. Alleman and E. Noam (eds.), *The New Investment Theory of Real Options and its Implications for Telecommunications Economics*, Kluwer Academic Publishers, 1999.

8.10.2. Approach taken by regulators

364. Although the conceptual basis of the relevance of asymmetric risks for determining interconnection charges is well founded in the academic literature, regulators have been reluctant to adjust returns on funds to incorporate the costs of any such risks.

365. For example, the ORG in Victoria, Australia in a recent price determination for electricity distributors noted:

> The distributors have raised a number of matters that they consider may give rise to asymmetric outcomes; including:
>
> • the operation of the regulatory regime, under which excess returns are capped, but losses are unbounded; and
>
> • risk created by the activities of the regulator and other decision makers (such as Parliament).
>
> Regarding the influence of the regulatory regime on the symmetry of cash flows, care must be taken not to overstate the extent to which there is residual downside. It would normally be the case that the act of regulation reduces the extent to which firms may earn returns that are greater than their costs of capital against the case were they unregulated. However, the electricity distributors are regulated because they are in a position of substantial market power for much of their market, and supply an essential service. Accordingly, the threat that the market for the services will disappear in the short term would appear remote. It should be noted that in competitive markets, competition 'regulates' the upside potential, while the potential for losses is unbounded.[66]

366. The ACCC, in assessing interconnection charges with Telstra's fixed PSTN, noted in relation to asymmetric risk that:

> …it has been argued in some regulatory contexts that an allowance for unique diversifiable risks could be accommodated by increasing the asset/equity beta or by making some allowance to a regulated firm's cash flows. However, it is difficult to estimate the size of these risks, and consequently the impact they should have on beta estimates. Notwithstanding this, the Commission has in some instances in the past chosen to adjust a regulated entity's equity beta to take account of these risks. In this instance, however, the Commission believes it is unnecessary to further adjust the asset beta to take account of unique diversifiable risks, ….[67]

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[66] ORG, *Electricity Distribution Price Review, Volume 1, Statement of Purpose and Reasons*, September 2000. p. 321.

[67] ACCC, *A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services*, July 2000, p.79.

8.10.3. Adjusting the return on funds for the cost of asymmetric risk

367. To the extent asymmetric risks are considered of practical relevance in determining interconnection charges under the Act, a key issue is how to adjust the return on funds to take accounts of these risks. There are basically two approaches.

Ad hoc approach

368. One approach is an *ad hoc* approach where the equity beta is adjusted upward to compensate for asymmetric risk. In the past this approach has been adopted by some regulators in Australia in the absence of a measure of the cost of asymmetric risk.

Estimation of the costs of asymmetric risks

369. A second approach is to attempt to estimate the costs of asymmetric risks and adjust the return on funds accordingly. This is made somewhat difficult as ideally one would like to observe the distribution of returns and how they are affected by regulation.

370. One approach to measuring the costs of these risks is to estimate the value of the real option to the access provider of delaying investment in its fixed PSTN and mark-up the return on funds accordingly. Not only is this consistent with the second potential source of asymmetric risk, it is also likely to capture the first source. As noted by Ergas and Small[68]:

> A fundamental connection is established between the value of the real option to delay investment, the risk of losses under regulation and the rate of economic depreciation. A practical benefit of this analysis is that existing empirical methods for estimating real options can now be used to estimate the size of the "investment incentive margin" that regulated firms should be allowed.

8.10.4. Summary of the implications of asymmetric risks

- 371. Conceptually, the costs associated with asymmetric risks under a TSLRIC pricing methodology should be reflected in interconnection prices. The difficulties are determining the practical relevance of these risks and measuring their costs.

The Commission seeks comment on the relevance of asymmetric risks for determining interconnection prices under the Act. The Commission specifically seeks comments on:

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[68] Small, J. P and H. Ergas, *The Rental Cost of Sunk and Regulated Capital*, 24 June 1999 at http://www.crnec.auckland.ac.nz/research/papers/wp17.pdf

- the sources(s) of asymmetric risk;
- the asset to which they should apply;
- the practical relevance of these risks and any factors that may offset these risks;
- the extent to which these risks are or can be compensated for in other aspects of TSLRIC (such as the equity beta or depreciation rates); and
- practical ways of estimating the costs of these risks.

9. Network operating and maintenance costs

372. As noted in Chapter 5, the fourth task in estimating TSLRIC is to estimate the forward-looking costs of operating and maintaining the network. Network O&M costs consist of:

- costs directly attributable to operating and maintaining the network; and
- a contribution to any costs common to operating and maintaining the network and other networks operated by the access provider.

373. Network O&M costs include costs such as fault repair, pro-active maintenance, network management and planning and network operations. Typically they are labour and material costs.

9.1. Approaches to estimating network operating and maintenance costs

374. Ideally, modelling network O&M costs involves three parts. The first is to identify the drivers of these costs. The second is to identify the relationships between the cost drivers and classes of network O&M costs. The third is to incorporate these relationships into the cost model. In practice however, such a modelling process is likely to be extremely complex, costly and time-consuming. As noted by OFTEL:

> In principle, a number of different approaches could be adopted to the modelling of operating costs in a bottom-up model. For example, one approach would be to model the impact of all key drivers that affect the level of operating costs in the network. This was considered by the Working Group to be an unduly large and complex modelling task. The alternative approach that has been adopted is to use the level of investment cost as a proxy cost driver for operating costs. Since it is recognised that investment cost is a proxy and not the true cost driver, the validity and accuracy of this approach depends critically upon calibrating the relationships between operating costs and investment costs by examining data from a range of operators.[69]

375. As a result, typically in TSLRIC cost models, network O&M costs are estimated as a percentage of network capital investment.[70] An example is detailed in Table7 below. First, network O&M costs are classified by network element. So for instance, costs incurred in maintaining switches are separated

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[69] OFTEL, *Long Run Incremental Costs: The Bottom-Up Network Model, Version 2.2*, March 1997, p.32.

[70] This is likely to be a good proxy for network maintenance costs as they are likely to vary directly with network investment. It is a poorer proxy for network operating costs as they vary in accordance with a range of other factors such as network usage.

from those incurred in maintaining cables and so on. Second, the percentages of O&M costs to the current replacement costs (capital investment) of each class of network elements are estimated. Third, the percentages are multiplied by the current replacement cost of the elements in each element class. This gives an estimate of the network O&M costs associated with each class of network elements.

Table 7: Example of estimating network O&M costs in TSLRIC models

Network element	Current replacement cost (capital investment) ($m)	Network O&M costs as a percentage of capital investment	Network O&M costs ($m)
Remote concentrator	10	7	0.7
Local switch	50	7	3.5
Fibre cable	40	10	4.0
Trenches	30	11	3.3

376. The difficult part is estimating the percentages. Although the aim is to estimate the percentages based on forward-looking O&M costs, this is rarely achieved in practice. As noted by HAI Consulting (builder of the HAI Model widely used in the U.S):

> Estimating LEC operating costs is more difficult than estimating capital costs. Few publicly available forward-looking cost studies are available from ILECs. Consequently, many of the operating cost estimates developed here must rely on relationships to and within historical ILEC cost information as a point of departure for estimating forward-looking operating costs.[71]

377. There are three approaches to estimating the percentages. One approach is to base them on the network capital investment and O&M costs incurred by the access provider in providing fixed PSTN services. The second is to base them on benchmarks estimated using cost data obtained from network operators in other countries with 'similar' fixed PSTNs. The third is to base them on the percentages used by other regulators. Each of these approaches is described and analysed below.

378. Although this approach is typically used in practice, it is important to recognise its shortcomings.

[71] HAI Consulting Inc., *HAI Model Release 5.0a Model Description*, 16 February 1998, pp.67-68.

379. First, it assumes strict relationships between capital investment and operating and maintenance costs and that this is stable over time. In reality these will vary in response to changes in relative factor prices (e.g. there is a trade-off between expensive low-maintenance assets and cheaper high-maintenance assets) and technological development (e.g. that maintenance requirements and operating costs fall over time as more modern assets are deployed). As a result, historical relationships will be less accurate over time.

380. Second, as O&M costs are based on network investment, this approach tends to amplify any errors made in the determination of the appropriate level of network investment and the allocation of joint network capital costs to different services

9.1.1. Approach 1: Access provider's actual costs

381. One approach is to base these percentages on the access provider's network capital investment and O&M costs. This would require the access provider to implement an accounting separation framework that would enable the required network capital investment and O&M costs to be measured. This framework would at least require the access provider to separate and allocate the following types of costs.

382. *Fixed PSTN capital investment* – It is necessary to separately value capital investments for each class of network element used to provide fixed PSTN services. Many of the network elements will solely be used to provide fixed PSTN services. For those elements that are also used to provide other network services, it will be necessary to share the costs using an allocation rule.

383. *Fixed PSTN O&M costs* – It is necessary to allocate these costs among the classes of network elements (remote concentrators, local switching, trenches, etc.). For costs incurred in the maintenance of fixed PSTN equipment this is likely to be straightforward. For other costs, such as network operating costs, an allocation rule will be required.

384. Once the capital investment costs and O&M costs for each network elements are measured, it is straightforward to calculate O&M costs as a percentage of capital investment costs.

385. There are a number of potential problems with this approach.

386. First, the access provider's actual network O&M costs may not reflect forward-looking costs. This could be the case for a number of reasons. One reason is that the access provider's operations and maintenance practices may not be fully efficient. Another is that the access provider's current network technology and design may not be the same as its forward-looking network technology and design. As network O&M costs are 'technology dependent', current O&M costs may therefore not reflect forward-looking O&M costs.

387. Second, the access provider's capital investments (assets) may not be valued on the basis of their current replacement costs. If this is the case, the percentages of current O&M to capital investment costs will be inappropriate even if the access provider's operations and maintenance practices are fully efficient. The percentages will be under- or over-estimated depending on whether the access provider's asset values over- or under- estimate the current replacement cost of the assets.

388. Third, as this approach relies heavily on the access provider to measure and allocate network O&M costs, it may lack transparency. Although the Commission can specify cost allocation rules, their implementation requires judgement. The approach taken by the access provider may not be readily observable to either the Commission or other parties.

389. Fourth, this approach gives the access provider a degree of control over the process. In order to gain a full understanding of what different cost items represent, it is likely to be necessary to understand the accounting systems from which they are generated. This may provide the access provider with a significant advantage over other parties.

9.1.2. Approach 2: Benchmarking approach

390. The second approach involves estimating these proportions on the basis of benchmarks of similar telecommunications networks in other countries. This approach involves the following steps.

1. Identifying efficient benchmark networks that are similar to the network being modelled.

2. Allocating network O&M costs to particular network asset classes.

3. Calculating the percentages of O&M costs to the replacement costs for each class of network asset.

391. The first step in this approach is to identify benchmark networks. This is made somewhat difficult as many telecommunications networks do not publish the required information on O&M costs and asset values. Among the set of telecommunications networks that do it is necessary to identify those that are of similar size and structure to the access provider's fixed PSTN and are efficient.

392. The most promising approach is to identify 'similar' telecommunications companies in the U.S. Importantly, the largest incumbent local exchange carriers (ILECs) are required to report network cost data to the FCC. These data are reported by the FCC in the Automated Reporting Management Information System (ARMIS) data base and are

publicly available.[72] The data base contains the required data for about 30 ILECs. These data have been used in network cost models in the U.S. to estimate network O&M costs to capital investment percentages.[73] This approach is likely to be most applicable for determining these percentages for Telecom's fixed PSTN.[74]

393. In using these data the Commission faces a number of tasks and decisions. The first is to exclude ILECs that are sufficiently dissimilar to Telecom's fixed PSTN. This needs to be considered further, but would likely involve excluding ILECs that have sufficiently dissimilar characteristics to Telecom's fixed PSTN (such as size, line densities, etc).

394. The second task is to determine 'efficient' percentages of O&M costs to capital investment. One approach is to use the smallest percentages for each network element, (i.e. select the smallest percentages for digital switching, circuit transmission, underground cable, etc. among the sample of ILECs). Under this approach it is unlikely that the smallest percentages will be from the same ILEC. Consider the example in Table 8 below. It is assumed there are two ILECs (A&B). ILEC A has smaller O&M costs to capital investment for cables and ILEC B has a smaller O&M costs to capital investment for switches. Using the smallest percentages for each network element will give an overall percentage of 60%. Each ILEC has an overall percentage of 70%. There are a number of potential reasons for this. One is that both ILECs' operations are inefficient but in different areas (switching or cabling). In this case the smallest percentages represent an efficiency frontier. Another is that the ILECs have allocated their O&M costs to switching and cables differently. In this case the smallest percentages represent an unattainable level of efficiency.

395. It is unlikely to be possible to distinguish between these possibilities. A conservative approach is to use a weighted average of the percentages (where the weights are based on asset shares) or the median. This reduces the possibility that the percentages represent an unattainable level of efficiency.

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[72] www.fcc.gov/wcb/armis/

[73] They are used in the HAI Model and the FCC's HCPM Model.

[74] ILECs have similar networks to Telecom's fixed PSTN. The same may not be the case for TelstraClear's fixed PSTN however.

Table 8: Example of determining benchmark operating costs/asset value percentages

	ILEC A	ILEC B
O&M costs ($)		
Switching	50	40
Cables	20	30
Total	70	70
Capital investment ($)		
Switches	100	100
Cables	100	100
Total	200	200
O&M costs/Capital investment (%)		
Switches	50	40
Cables	20	30
Total	70	70
Smallest O&M costs/Capital invest. (%)		
Switches	40	40
Cables	20	20
Total	60	60

396. There are a number of potential problems with the benchmarking approach.

397. First, as noted above, using the average or median percentages of O&M costs to capital investment may overestimate the efficient costs.

398. Second, as the O&M costs are historical they may not reflect forward-looking costs. In particular, for a number of reasons, it is unlikely the network technology and design used by the ILECs will be the same as the forward-looking network technology and design for Telecom's fixed PSTN. One reason is that the network technology employed by ILECs in the U.S. differs to those used in New Zealand. Further, they are likely to be dated.[75] In some

[75] There are trade-offs between capital investment costs and O&M costs. For example, the greater the spare capacity within a network to cater for faults, the lower are likely to be the O&M costs associated with network repairs. Basing network O&M cost mark-ups on a network that has greater spare capacity than the network modelled in the TSLRIC model will result in efficient network O&M costs being under-estimated.

cases, network cost modellers have altered the ratios in an attempt to better reflect the costs consistent with forward-looking network technology.[76,77]

399. Third, expenses in the U.S. differ from those in New Zealand (e.g. differences in labour costs).

9.1.3. Approach 3: Percentages used by regulators in other countries

400. A third approach is to use the percentages used by regulators in other countries in estimating TSLRIC. There are two major advantages of this approach. First, the percentages used by other regulators are often based on confidential as well as publicly available information. This improves the information base upon which the Commission's judgements are made. Second, in most cases, they have been examined and tested by industry.

401. Table 9 presents the proportions used by the ACCC in estimating the TSLRIC of providing interconnection services using Telstra's fixed PSTN. These proportions were based on data supplied by an operator of a fixed PSTN in Australia (Cable and Wireless Optus) and were subject to review by other parties, including Telstra.

402. Table 10 presents the percentages of network O&M costs to capital investments proposed by the FCC in 1999. These were based on data from ILECs contained in the FCC's ARMIS data base.

Table 9: Network O&M costs as a proportion of capital investment: ACCC 2000

Network element	O&M cost (% of replacement cost of asset	Network element	O&M cost (% of replacement cost of asset)
IRIM	7	STM-1 Regenerator	10
IRIM port	7	STM-4 Regenerator	10
IRIM site	12	STM-16 Regenerator	10
RSS/RSU	7	Repeater Site	10

[76] For example, in the HAI Model network operations expenses are divided by 2 in an attempt to better reflect forward-looking network operations expenses.

[77] Care must also be taken to adjust the asset values in the ARMIS data bases for differences between book and current replacement values. The asset values reported in ARMIS are book values, yet the required ratios are expenses to the replacement costs of the assets. See FCC *Tenth Order and Report*, CC Docket No. 96-45, Released November 2, 1999, pp143-145 for details of how the FCC made this adjustment.

RSS/RSU port	7		
RSS/RSU site	11	12 fibre cable/metre	10
LAS	7	24 fibre cable/metre	10
LAS port	7	48 fibre cable/metre	10
LAS processor	7	96 fibre cable/metre	10
LAS site	11		
TS port	7	Trench/metre-CBD	10
TS processor	7	Trench/metre-Metro	10
TS site	10	Trench/metre-Provincial	10
		Trench/metre-Rural (ploughed)	10
SDH MUX STM1	10	Trench/metre-Rural (ploughed-no duct)	10
SDH MUX STM4	10		
SDH MUX STM16	10	Signalling transfer point	10
PDH: multiplexer 2-8 Mbit/s	10	Core network management centre per switch node	10
Digital cross connect	10		
Line termination system	10	Synchronisation SSU license per tandem switch	10

Source: ACCC, *A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services*, July 2000, Table A1.6.

Table 10: Network O&M costs as a percent of capital investment: FCC 1996

Network element	**O&M cost (% of replacement cost)**
Circuit equipment	2.00
Digital/analogue switching (electronic)	5.58
Poles	2.19
Aerial cable – fiber	0.73
Aerial cable – copper	6.69
Underground cable – fiber	0.84
Underground cable – copper	2.10
Buried cable – fiber	0.61
Buried cable – copper	4.46

Source: FCC, *Tenth Order and Report*, CC Docket No. 96-45, Released November 2, 1999, Appendix A, Part 3: Capital Costs.

403. Many of the criticisms of the two other approaches also apply to this approach.

404. In applying the percentages used by other regulators the Commission may assess the methodology used to estimate the percentages. To the extent that the methodology used by a particular regulator is less robust the Commission may consider giving the percentages less weight. Further, the Commission may examine the characteristics of the benchmark networks used by particular regulators to estimate these percentages. To the extent the networks are more 'similar' to the access provider's fixed PSTN, the Commission may consider giving the percentages more weight.

9.2. Which approach?

405. Each of the approaches has weaknesses. No one approach is *a priori* the first best approach to estimating forward-looking network O&M costs. The Commission's decisions on these costs will necessarily require some judgement. To the extent resources and time are available, it may be advisable to use more than one of these approaches to establish a plausible range of these percentages. The Commission is however mindful of adding to the burden of the cost modelling. Whatever approach is adopted by the Commission, it is important that it be supplemented by information on these percentages available to the parties to the dispute. This information could be from their own operations or affiliates in other countries.

The Commission seeks feedback on:

— which of these approaches (or other approaches) are likely to provide the most accurate estimates of forward-looking network O&M costs;

— conceptual issues in implementing these approaches;

— the availability of data and information to implement these approaches; and

— the time frames within which the approaches could reasonably be implemented.

10. Non-network costs

406. Non-network costs are costs that are causally related to the provision of fixed PSTN services (including interconnection services), but are not network costs. Non-network costs are predominately support services such as purchasing and supply, IT services, human resource management, accounting and finance and general administration. They require capital investment as well as labour and materials. As these support services are necessary in order to provide interconnection services, they form part of TSLRIC.

10.1. Approaches to estimating non-network costs

407. As with network O&M costs, estimating forward-looking non-network capital investment and O&M costs is difficult. Theoretically, drivers of non-network costs could be identified and modelled and incorporated into a forward-looking cost model. Such tasks are costly, time-consuming and information-intensive.

408. Non-networks costs are typically incorporated into TSLRIC models using simpler methods. Typically non-network capital investment costs are estimated as percentages of network investment costs. Some non-network O&M costs are estimated as percentages of the costs of capital equipment. For instance, the costs of maintaining and operating motor vehicles are estimated as a percentage of capital investment in motor vehicles. Other non-network O&M costs are estimated as percentages of network O&M costs. For instance, human resource management costs are estimated as a percentage of network O&M costs.

409. An example may assist on how this all gets put together. Table 11 presents the estimates of network and non-network capital investment and O&M costs associated with a switch. Say the current replacement cost (capital investment) of the switch is $1m. Assume that network O&M costs as a percentage of the capital investment in the switch (estimated in Chapter 9) is 10 per cent. As shown in Table 11, this gives network O&M costs of $100,000.

410. Now consider non-network capital investment costs (office accommodation and general computing). Assume that the non-network to network capital investment percentages for these assets are 1% and 2% respectively. These percentages imply that each $100 of network capital investment (in this case a switch) requires $1 and $2 respectively of supporting office accommodation and general computing capital

investment.[78] This gives non-network capital investment costs of $10,000 for office accommodation and $20,000 for general computing.

411. Finally consider non-network O&M costs. There are two parts to these costs. Those costs of operating and maintaining non-network assets are estimated as percentages (7% and 10% respectively) of the capital investment in office accommodation and general computing. Other non-network O&M costs (such as accounting and finance and human resource management) are estimated as percentages (8% and 3% respectively) of network O&M costs.

Table 11: Example of network and non-network capital investment and O&M costs

	% of network investment cost	% of non-network investment cost	Capital investment cost ($)	% of network O&M costs	O&M cost ($)
Network asset (switch)			1,000,000		
Network O&M	10				100,000
Non-network assets					
Office accommodation	1		10,000		
General computing	2		20,000		
Non-network O&M					
Office accommodation		7			700
General computing		10			2,000
Accounting and finance				8	8,000
Human resource management				3	3,000

412. There are three types of non-network cost percentages that the Commission needs to estimate. They are:

1. Non-network capital investment as a percentage of network capital investment (e.g. office accommodation, vehicles, general computing, etc.)

[78] These percentages are the same for all network assets. That is it is assumed that an additional $1 of office accommodation is required for each $100 of network capital investment independently of whether the network element is a switch, a cable, a trench, etc.

2. Non-network operating and maintenance costs as a percentage of non-network capital investment (e.g. operating and maintenance of office accommodation, vehicles, etc.)

3. Other non-network O&M costs as a percentage of network O&M costs (e.g. general administration, human resource management, accounting and finance, etc.)

413. There are three approaches to estimating these percentages.

10.1.1. Approach 1: Access provider's actual costs

414. One approach is to base these percentages on the access provider's actual capital investments and O&M costs. This approach would require the access provider to implement an accounting separation framework that would enable the required network and non-network capital investment and O&M costs to be measured.

415. Identifying and separating fixed PSTN non-network costs will likely require sophisticated activity-based costing systems. For example, allocating office accommodation would involve first determining what the accommodation is used for (such as IT services, accounting and finance, general administration, etc.) and then allocating those support services to the access provider's fixed PSTN, its cellular network, its retailing and marketing functions and so on.

416. A major problem with this approach is that using the access provider's actual costs to estimate the percentages is a movement away from the ideals of bottom-up cost modelling. However, it may provide useful proxies. The accuracy of the proxies will depend upon a range of factors. One factor is the sophistication of the access provider's costing and cost allocation systems. A second factor is the access provider's efficiency. A third factor is how the access provider values its assets. Ideally they should be valued on the basis of current replacement cost. This is unlikely to be the case.

417. Another problem with this approach is that the allocation process required is likely to be complex and require a degree of judgement. As a result, the approach taken by the access provider may not be readily observable to either the Commission or other parties.

10.1.2. Approach 2: Benchmarking approach

418. The second approach involves estimating the percentages on the basis of benchmarks of similar telecommunications networks in other countries. As with network O&M costs, the most promising source of information is data on ILECs reported by the FCC in its ARMIS database. The database reports the book value of assets separated into network assets and general support assets (e.g. land, buildings, vehicles, furniture, general support computers, etc). It

also separates O&M costs into network expenses, general support expenses (i.e. expenses related to the operation and maintenance of general support assets) and general and administration expenses (e.g. accounting and finance, human resources, legal, information management, etc.) Again this approach is best suited to Telecom's fixed PSTN.

419. Proxies for the proportions can be estimated using the following steps.

Step 1: Remove from the sample ILECs that are sufficiently 'dissimilar' to Telecom

420. It is preferable to select ILECs with local networks that are of similar size and structure to Telecom's fixed PSTN (in terms of line densities, terrain, etc.).

Step 2: Adjust asset values and O&M costs to reflect those relevant to providing fixed PSTN services

421. The general support capital investment and O&M costs and the general and administration costs reported in the ARMIS database cover the entire operations of each ILEC. For example, the accounting and finance expenses captured in general and administration include costs associated with each ILECs retail activities as well as providing fixed PSTN services. As these types of costs are not part of the TSLRIC of providing fixed PSTN services they should be excluded. To do so however requires some degree of judgement. For example, in developing a TSLRIC cost model of Telstra's fixed PSTN in Australia, NERA made the adjustments to the FCC data listed in Table and Table.

Step 3: Calculate the required percentages for each ILEC in the sample

Step 4: Estimate the percentages on the basis of the median or average of the sample

422. As with network O&M costs, determining the efficient percentages is subject to error. Selecting the smallest percentages may be misleading if O&M costs or capital investments have been misclassified. A conservative approach is to use a weighted average or median of the percentages.

423. The same problems with using this approach to estimate network O&M costs are relevant here. First, using the average or median percentages may overestimate efficient non-network costs. Second, as the non-network costs are historical they may not reflect forward-looking costs. Third, to the extent costs differ between the U.S. and New Zealand (such as legal costs for instance) the percentages may be misleading.

424. Probably the major issue with this approach however is the need to adjust the non-network costs reported by ILECs to reflect those relevant to fixed PSTN services (Step 2 above). The problem is that in order to accurately determine the required adjustments disaggregated information on ILECs

costs is required. Specifically, it is necessary to separate out non-network costs that are related to the provision of fixed PSTN services. Information at a sufficiently disaggregated level to do this is not available in the ARMIS database. As a result, any adjustments are likely to be subjective.

10.1.3. Approach 3: Percentages used by regulators in other countries

425. A third approach is to use the percentages used by regulators in estimating TSLRIC in other countries.

426. Tables 12 and 13 present the proportions used by the ACCC in estimating the TSLRIC of providing services (including interconnection services) using Telstra's fixed PSTN. These proportions were based on data on ILECs obtained from the ARMIS data base. It includes judgements as to the proportions of non-network investments that are relevant for providing fixed PSTN services.

Table 12: Non-network investment costs as a percentage of network investment costs: ACCC 2000

Asset class	Percentage of capital investment relevant to fixed PSTN services	Local[1]	Trunk[2]
Land	50	0.10	0.14
Vehicles	90	0.90	0.03
Other equipment	90	0.79	1.18
Buildings	50	1.79	3.73
Furniture	50	0.15	0.03
Office equipment	50	0.37	0.02
General computers	40	0.80	0.31
Total		**4.89%**	**5.43%**

Notes:
1 Local includes the access network and remote units, LASs and remote to LAS links
2 Trunk includes the remainder of switching and transport.
Source: NERA, *Estimating the Long Run Incremental Cost of PSTN Access, Final Report for the ACCC*, January 1999, Table 2.12.

Table 13: Non-network O&M costs as a percentage of network O&M costs: ACCC 2000

Non-network cost category	Percentage of O&M costs relevant to fixed PSTN services	Percentage of network O& M costs
Wholesale sales & marketing		6.0
Executive & planning	40/60	0.8
Accounting & finance	60	2.4
External relations	60	1.9

Human resources	50	1.6
Information management	40	5.2
Legal	50	0.3
Procurement	80	0.5
Other	50	6.0
Total		**24.8**

Sources
ACCC, *A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services*, July 2000, Table A2.5.
NERA, *Estimating the Long Run Incremental Cost of PSTN Access, Final Report for the ACCC*, January 1999, Table 2.13.

427. Many of the criticisms of the two other approaches also apply to this approach. As suggested in Chapter 9, in applying percentages used by other regulators the Commission may consider giving the percentages used by a particular regulator more or less weight depending on the methodology employed and the benchmark networks used.

10.2. Which approach?

428. As with estimating network O&M costs, each of the approaches has its weaknesses. Nevertheless the Commission must decide on the size of efficient non-network capital investment and O&M costs. The Commission's decisions on these costs will necessarily require some judgement. To the extent resources are available, it is advisable to use more than one of these approaches to establish a plausible range. The Commission is however again mindful of adding to the burden of the cost modelling. Whatever approach is adopted by the Commission, it is important that it be supplemented by information on these percentages available to the parties to the dispute. This information could be from their own operations or affiliates in other countries.

The Commission seeks feedback on:

— which of these approaches (or other approaches) are likely to provide the most accurate estimates of forward-looking non-network costs;

— conceptual issues in implementing these approaches;

— the availability of data and information to implement these approaches; and

— the time frames within which the approaches could reasonably be implemented.

11. Structure of prices

429. There are essentially two steps to determining interconnection prices on the basis of TSLRIC. The first is to determine the costs to be recovered through interconnection charges. The second is to determine the structure of the interconnection prices. In this section the second step is examined.

430. There is a multitude of pricing structures that could enable the access provider to recover the cost of providing interconnection services. The simplest pricing structure is a flat per minute or per call charge. There are two primary aims of departing from simple pricing structures. One is to better reflect in interconnection charges the costs of providing interconnection services to access seekers. This can result in differences in interconnection charges by time of day, day of the week, geographic region and by volume purchased. The second aim is to more efficiently recover the fixed costs of providing interconnection services. This can result in multi-part pricing and differences in interconnection charges by the time of day and day of the week. However there is a trade-off. The more complex the pricing structure the more difficult the costing exercise and the more information that will be required (such as information on the demand characteristics for telecommunications services).

431. There is also the issue of whether a price derived from efficient costs is workable for the parties. This issue has two parts. First, is whether it is appropriate to implement a pricing structure which is not sought by any party or in other words if the Commission could decide on a more appropriate pricing structure than the parties. The second is whether there is good reason to use the structure of the most recent agreements as a starting point and only move away from it if a good case can be established.

11.1. Recent interconnection agreements

432. The price structures currently differ by the type of interconnection service.

Interconnection for national and international toll by-pass calls

433. Under the interconnection agreements between Telecom and TelstraSaturn and Telecom and Clear Communications commencing in August 2000 and October 2000 respectively, interconnection prices for toll by-pass calls have the following structure:

- a flagfall fee for the first minute or part thereof for both originating and terminating services and per-second charges thereafter;
- differing charges depending on the geographic area in which the call originates or terminates; and

- differing charges depending on whether the point of interconnection is in the same area as where the call originates or terminates.

434. The charges do not vary over the time of day or the day of the week.

*Interconnection for toll-free call*s

435. Under the most recent interconnection agreements between Telecom and TelstraSaturn and Telecom and Clear Communications, originating toll-free calls have the following price structure:

- a flagfall fee for the first minute or part thereof and per-second charges thereafter;
- differing charges depending on the geographic area in which the call originates; and
- differing charges depending on whether or not the point of interconnection is in the same area as where the call originates.

436. The charges do not vary over the time of day or the day of the week.

Interconnection for mobile to fixed-line calls

437. Under the July 2001 interconnection agreement between Telecom and Vodafone, charges for terminating mobile to fixed-line calls have the following structure:

- a per minute charge (rounded to the nearest full minute);
- differing charges by time of day;
- differing charges by volume of interconnection; and
- differing charges depending on whether or not the point of interconnection is in the same area where the call terminates.

11.2. Structure of prices and efficiency

438. The structure of prices can affect a range of decisions of access providers and access seekers. Potentially, departures from simple pricing structures can encourage more efficient decisions, although care must be taken in their design and implementation.

Decisions of access providers in investing in fixed PSTNs

439. The structure of pricing over the time of day is important in encouraging efficient decisions concerning the timing of investment in network capacity. Investment in network capacity is primarily driven by

usage during the busy hour. In the short term, an increase in call traffic in the busy hour can create network congestion. In the long term, it is likely to necessitate investment in additional network capacity. In order to encourage efficient timing of investment, these costs should be signalled through different prices over the time of day and day of the week.

Decisions of access seekers to duplicate parts of existing fixed PSTNs

440. Differences between interconnection prices and the costs of providing interconnection services across regions can potentially result in inefficient 'build-buy' decisions. For instance, if interconnection prices are set on the basis of a national average of costs, they are likely to be above cost in CBD areas and below cost in rural areas. As a result, access seekers may find it more profitable to duplicate parts of existing PSTNs in CBD areas rather than buy interconnection services. To the extent this duplication increases industry costs it is likely to be inefficient.

Minimising regulatory and compliance costs

441. Complex pricing structures can be costly to determine and administer and subject to error. They can also impose greater costs on industry in terms of compliance. Potentially, the sum of these costs could outweigh the efficiency benefits associated with a more finely graded pricing structure.

11.3. Average per-minute pricing

442. A simple approach to setting interconnection prices is to divide the total costs of providing interconnection services by the forecast number of interconnection minutes, to give an averaged per-minute charge. This approach can be summarised as 'a minute is a minute is a minute'. Although average cost pricing is simple and transparent to administer, it may lead to a number of problems.

443. First, it will likely result in the result in the inefficient under-use of telecommunications services (such as toll calls). As noted above, it may be more efficient to recover a greater proportion of fixed and common costs through setting different interconnection prices over the day or week.

444. Second, average per-minute pricing does not necessarily create incentives to invest efficiently. At times when the network is used to capacity, the true marginal cost of a call can be quite high, once congestion costs have been taken into account. Average per-minute pricing would not signal these congestion costs to access seekers. Therefore, the use of telecommunications services (and in turn interconnection services) at peak times may be higher than it would be if interconnection prices reflected the costs of usage at peak times. In turn this is likely to inefficiently bring forward investment in network capacity.

445. Third, average per-minute pricing can encourage inefficient 'build-buy' decisions. For example, say that there are two regions – Rural and Urban. Assume that the costs of providing interconnection services in the Urban region are lower (at least, on an average per minute basis) than they are in the Rural region. An averaged interconnection price would lie somewhere between the per-minute cost in Rural and in Urban. Given these prices it may be profitable for an access seeker to build its own network in Urban even if it is more efficient to buy interconnection services from the access provider.

11.4. Possible departures from simple average per-minute pricing

446. The simple average per-minute pricing structure outlined above is not the only possible pricing structure. It may be possible to devise more complex pricing structures that address some of the problems described above. Alternative pricing structures include:

- prices that vary by time of day and day of the week;
- prices that vary by geographic region;
- prices that vary by distance;
- multi-part pricing; and
- volume discounts.[79]

447. Although more complex pricing structures may produce more efficient outcomes, the Commission is mindful that complex pricing arrangements are difficult, costly and time-consuming to implement. Further, errors can be more harmful than omissions. As noted by Laffont and Tirole:

> …..imperfectly determined access charges increase(s) the possibilities open to entrants in arbitraging by purchasing undervalued pieces and leaving others aside. However, access price averaging also creates scope for substantial arbitrage by entrants (if they can buy individual elements or services separately) by putting together in the same formula services or elements that have different costs or values to the entrants.[80]

448. Laffont and Tirole further argue:

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[79] These are not the only possible departures from simple average per-minute pricing. Another possible pricing structure involves capping interconnection charges. This has been used in some jurisdictions for local interconnection for data calls.

[80] Laffont and Tirole, J-J and Tirole, J., *Competition in Telecommunications*, MIT Press, 2000, p. 141.

> .. access charge aggregation does matter geographically, in view of varying topologies and customer densities. It also is a subject of an unresolved debate for time-of-day pricing of access. Telephone networks' marginal costs are very small off peak and quite high at peak. While economists rightly argue in favour of peak-load pricing of access … the implementation of peak-load pricing still has to be carefully designed. Besides the standard issue of computing off-peak and peak marginal costs, the new and interesting issue in a competitive environment with access is that several operators are jointly responsible for the timing of the peak during the day. This fact may induce some gaming on their part, and in any case adds to the difficulty encountered when foreseeing the location of the peak.[81]

11.4.1. Differentiating by time of day

449. As noted above, setting different interconnection charges by the time of day can provide two sources of gain. [82]

450. The first source of gain is to more efficiently recover fixed and common costs. As noted above, these costs can be more efficiently recovered by charging higher mark-ups over marginal cost for users whose demands for telecommunications services is less sensitive to higher prices. One way in which this can be done is by charging higher prices for interconnection services during business hours.[83]

451. Although setting different interconnection charges by the time of day can potentially result in a more efficient recovery of fixed and common costs, it faces practical difficulties. In particular, it requires information on the time of day usage profiles of different classes of consumers and the relative sensitivities of their demands for telecommunications services to price. One possible approach of the Commission that overcomes some of the need for this information is to mirror the time of day structures currently used in retail prices. The problem with this approach is that it runs the risk of 'institutionalising' current retail price structures.

452. The second source of gain is to signal to access seekers the cost of using telecommunications services during peak times when the network is congested. Setting interconnection prices to provide such signals is likely to be problematic. Not only does it require the Commission to identify the busy hour (which is likely to differ at different points of the network), but it

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[81] *op.cit*, pp. 140-141.

[82] It should be noted that time of day interconnection charges should be set to recover a given contribution to common costs. In that way the charges will be consistent with TSLRIC.

[83] This is based on the presumption that on average business users are less sensitive to higher prices for telecommunications services than residential users. This may not universally be the case.

requires the Commission to identify the differences in costs between busy and non-busy periods.

11.4.2. Differentiating by geographic region

453. The costs of providing interconnection services are likely to vary throughout New Zealand. Several factors drive these differences, including:

- *geography*: costs are typically higher to more distant locations; and
- *traffic volumes:* measured on an average, per-minute cost basis, costs are likely to be higher in areas with low traffic volumes.

454. Reflecting differences in regional costs in interconnection prices is likely to result in more efficient 'build-buy' decisions. Simple national average prices blur the differences between high cost and low cost areas. In low cost areas (such as CBDs), access seekers may have an artificial incentive to by-pass the access provider. In high cost areas it may discourage efficient investment. There is a trade-off. The more averaged are interconnection charges, the greater the prospect of inefficient duplication in some areas and under-investment in others. The more interconnection charges reflect geographic differences in costs, the more difficult the modelling exercise, the more extensive the information requirements and the greater the likelihood of significant errors.

11.4.3. Differentiating by distance

455. A related issue is whether interconnection prices should differ depending on the distance between the point of interconnection and the point the call is originated or terminated. For instance, a call handed over to Telecom in Wellington that is destined for a party in Wellington will use less of Telecom's fixed PSTN than a call that is handed over in Wellington destined for a party in a neighbouring area. Currently, interconnection charges in New Zealand reflect some of these differences.

456. As a proportion of the costs of providing interconnection services (such as transport costs) vary by distance, distance-related charges are likely to be desirable. Distance-related charges are likely to encourage more efficient decisions regarding the location of points of interconnection. If interconnection charges reflect differences in the costs of originating or terminating calls from different points in the network, access seekers will make more efficient decisions on whether to build points of interconnection closer to end-users.

457. Although differentiating interconnection charges by distance may be desirable there are limits. The larger gains are likely to come from taking account of the largest differences in costs. Further, the more finely tuned

interconnection charges become, the more complex and less perfect the costing exercise will be.

458. If the Commission decides to adopt distance-related pricing, it will need to:

- classify points of interconnection into 'like' groups based on the average distance to end-users; and
- determine differences in the cost of transporting calls to end-users across these groups.

11.4.4. Multi-part pricing

459. As discussed above, average per-minute pricing may result in the under-use of telecommunications services, particularly during times when the network is not congested. A potential solution to this problem is to employ two-part pricing. Two-part prices are a combination of a fixed fee for 'access' plus a variable, usage-related component. The intuition behind two-part prices is as follows. It is undesirable for consumption to be curtailed because usage charges exceed marginal cost. Yet fixed and common costs still need to be recovered. If a lump sum is charged to gain access to the service (which covers fixed and common costs) and usage charges reflect marginal costs, consumption levels are likely to be more efficient.

460. However, there are trade-offs to be considered when setting the fixed and variable components of a two-part price. The first part (the fee for 'access') should not be set so high as to deter access seekers altogether. Yet the second part (the price per minute of use) should not be so high as to discourage use of the service. As noted by Laffont and Tirole:

> …[C]onsider a two-part tariff composed of a fixed (subscription, monthly, connection) fee together with a (per-minute) variable charge. A two-part tariff should economically be analysed as the provision by the firm of two services: the fixed charge entitles the customer to connect to the service, and the variable charge covers the actual use of the service. These two services ('connection' and 'consumption') are complements: the more consumers are connected to the service, the higher the variable consumption; similarly, a reduction in the variable charge raises the number of consumers who are willing to pay the fixed fee to connect. The two prices should therefore be coordinated. It is worth losing some revenue on connections if doing so boosts variable consumptions, and conversely.[84]

461. Two-part interconnection prices could take two forms.

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[84] *op.cit*, p. 69.

Block access approach

462. Under a block access approach, an access seeker would pay:

- an up-front fee which covers the access seeker's contribution to fixed and common costs; and
- a per minute usage fee equal to the marginal cost of the interconnection service.

463. The advantage of this approach (over simple average per-minute pricing) is that access seekers have greater freedom over how they recover their contribution to fixed and common costs. Specifically, access seekers can mark-up their retail prices in a manner to most efficiently recover their contribution to these costs.

464. In practice however setting the up-front fee is fraught with difficulties. Setting the fee too high for a particular access seeker may discourage the access seekers from buying any of the interconnection service at all. That is it may deter entry. One approach to overcoming this problem is to set the up-front fee on the basis of the amount of the interconnection service the access seeker is likely to purchase (on the basis that the larger the access seeker the larger the up-front fee the access seeker can accommodate). However, this simply converts the two-part pricing structure to average per-minute pricing.

Per-call basis

465. Under a per-call basis, an access seeker would pay:

- a flagfall per interconnect call; and
- a per minute usage fee for the interconnection service.

466. The aim here is to:

- ensure the flagfall at least covers the cost of setting up the interconnect call; and
- to the extent possible, reduce the price of additional interconnection minutes as close as possible to marginal cost.

11.4.5. Volume discounts

467. The cost of providing interconnection services can differ depending on the volume of interconnection minutes purchased. For example, the 'fixed' costs of negotiating agreements and installing physical interconnection links are lower on a per unit basis the larger the volume of interconnection minutes purchased.

468. Volume discounts based on such differences in costs are desirable. Failing to signal differences in costs related to volume in interconnection prices runs the risk of inefficiently encouraging small access seekers to enter and inefficiently discouraging access seekers to lower costs through economies of scale. This will add costs to the industry. However, care must be taken in determining volume discounts. Volume discounts that are not cost-based may deter the efficient entry of small access seekers.

11.4.6. Summary

469. Although complex interconnection pricing structures can potentially result in more efficient outcomes, the Commission is conscious of the need to develop workable solutions that are not costly to implement and reduce the scope for errors. One possible approach is to use the prices structures used in the most recent interconnection agreements (noted above) as a starting point and move away from that structure only where there is good reason to do so. Another is for the Commission to determine an average price for a particular interconnection service, and encourage the access provider and the access seeker to negotiate over at least some elements of the pricing structure (such as time of day or day of week charges).

The Commission is aware of the potential benefits of departures from simple average per-minute interconnection prices. The Commission is also conscious of the need to minimise the complexity of the price structure in order to make it workable. The Commission seeks comments on:

The most appropriate approach for determining the interconnection pricing structure including:

- the merits of using the price structures in the most recent interconnection agreements as a starting point and moving away from those structures only if a good case can be established.

- the appropriateness of the Commission either selecting a pricing structure that is not sought by either party or of the Commission determining the average price for the interconnection service and leaving the parties to negotiate the pricing structure.

The relative merits of different pricing structures including:

- which factors (time of day, geographic area, etc.), if any, should be the basis for departures from simple average per-minute pricing;

— the specifics of the departures (i.e. how may geographic interconnection price points there should be);

— the merits of having relative few or large numbers of interconnection price points;

12. Setting prices for interconnection services provided on fixed PSTNs other than Telecom's

470. As noted in Chapter 2, the Commission may be required to determine prices for interconnection services provided on fixed PSTNs other than Telecom's. In determining such prices, the Commission is required to consider basing the prices on:

> the price determined by the Commission (if any) for interconnection with a network of Telecom's that corresponds most closely in nature to the access provider's network.

471. The choice facing the Commission is whether the prices of interconnection with fixed PSTNs other than Telecom's should be based on an estimate of TSLRIC for interconnection services provided using Telecom's PSTN, or a separate estimate of TSLRIC [85].

472. In considering this choice it is relevant to recognise that under the Act, Telecom is the only access seeker that can request the Commission to determine prices for interconnection services with other fixed PSTNs. The range of interconnection services to which this applies therefore appears to be limited to:

- termination of local calls originating on Telecom's fixed PSTN (local interconnection services);
- termination of national and international toll calls originating on or going via Telecom's fixed PSTN [86];
- termination of mobile to fixed-line calls originating on Telecom's mobile network; and
- origination of toll-free calls that are made by an A-party connected to the fixed PSTN to a B-party connected to Telecom's fixed PSTN.

473. Although other fixed PSTNs may only be a fraction of the size of Telecom's fixed PSTN, the commercial necessity for Telecom (or any fixed PSTN provider) to provide its customer with any-to-any connectivity[87]

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[85] The Commission may also select Bill and Keep (either pure or hybrid form) for pricing interconnection services.

[86] For example Telecom may receive an international call, provide national transport and deliver it to another NZ fixed PSTN for termination.

[87] Any-to-any connectivity requires that end-users connected to a network can communicate with end-users connected to all other networks.

potentially provides fixed PSTN providers with the scope to increase the price of interconnection services above costs.

474. The Commission's preliminary proposal is determine prices for local interconnection services between Telecom's fixed PSTN and other fixed PSTNs on the basis of bill and keep or a hybrid of bill and keep and TSLRIC prices (see *Interconnection Methodology Paper*).[88]

475. In considering whether interconnection prices for other fixed PSTNs should be set on the basis of TSLRIC for Telecom's fixed PSTN, or a separate estimate of TSLRIC, it is useful to separate the discussion into two parts. The first part considers the choice where the interconnection services provided by Telecom and other fixed PSTN providers are the same. The second part considers the choice where the services are different.

12.1. Interconnection services are the same

476. Say the interconnection services are the same. By the same, we primarily mean three things:

- the services are provided in the same geographic 'cost' area;
- the POI is at the same level of the network[89]; and
- the services carry the same type of call traffic.

477. In considering charges for interconnection with other fixed PSTNs, it is useful to consider the consequences of setting charges that differ to those set for Telecom.

Consequences of setting interconnection charges above Telecom's

478. If over the long run a provider can provide telecommunication services (including interconnection services) at a lower cost than Telecom, then it may be efficient for the provider to build an alternative fixed PSTN. However, encouraging entry by higher costs providers will not be efficient.[90] Setting charges for interconnection with other fixed PSTNs above the long-run forward-looking costs incurred by Telecom in providing the same services will not send efficient investment signals. Rather, it creates the prospect of encouraging inefficient duplication of Telecom's fixed PSTN.

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[88] Under the hybrid approach bill and keep will be used up to specified limit of out-of-balance traffic and TSLRIC prices thereafter.

[89] This means that the points in the network where the operators hand over calls are similar.

[90] Unless of course there are offsetting factors such as greater service quality or functionality.

479. Say the Commission sets the charges for terminating national toll calls on Telecom's fixed PSTN at 2 cents per minute based on the TSLRIC of providing those services. Now say the Commission sets charges for terminating national toll calls on TelstraClear's fixed PSTN at say 3 cents per minute. This will likely 'bias' network competition in favour of TelstraClear over Telecom. Even if TelstraClear's costs in terminating such calls are greater than Telecom's (say 2.5 cents per minute), it will still have an incentive to invest in infrastructure to provide the service. This may be inefficient.

480. As noted by the ACCC in examining pricing approaches for interconnection with non-dominant or small fixed networks:

> Smaller network operators who cannot price at or below that of the TSLRIC price of the dominant or larger network for the same service functionality because of higher costs over time are less efficient than Telstra. In terms of efficient pricing principles discussed above, the imposition by a smaller network of prices that were clearly above the prices for the same service by a larger network over time would promote inefficient entry and investment by smaller networks and would not be in the long-term interests of end users.[91]

Consequences of setting interconnection charges below Telecom's

481. The opposite is the case if prices for interconnection with other fixed PSTNs are set below Telecom's interconnection price. In this case, the efficient entry of other fixed PSTN providers will potentially be discouraged. Say the Commission sets the charges for interconnection with Telecom's fixed PSTN at 2 cents per minute and those with TelstraClear's fixed PSTN at say 1 cents per minute. In this case, even if it costs TelstraClear less to provide interconnection services than Telecom (say 1.5 cents per minute), it will be discouraged from investing in infrastructure to provide the service. In the long run this is likely to be inefficient.

482. In summary, the long-run forward-looking costs incurred by Telecom in providing interconnection (and other services) using its fixed PSTN is one of the elements that other providers should endeavour to beat[92] in considering whether to invest in competing fixed PSTN infrastructure. Setting prices for interconnection with other fixed PSTNs equal to those set by the Commission for Telecom (for the same service) will set the appropriate long-run cost target.

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[91] ACCC, *Revised pricing guidelines for access prices of PSTN terminating and originating access services provided by non-dominant or smaller fixed networks, Pricing Principles Paper*, January 2002, p.16.

[92] Other factors that are likely to affect the decision of other providers to enter is the quality and range of services they can offer (relative to Telecom).

12.2. Interconnection services are not the same

483. Does this still hold if the interconnection services provided by Telecom differ from those provided by other fixed PSTN providers? There are three sources of differences that may be relevant in this regard:

- differences in the geographic distribution of traffic;
- differences in the network level at which interconnection is provided; and
- differences in the types of traffic (such as voice and data traffic).

Differences in the geographic distribution of traffic

484. Telecom's fixed PSTN is ubiquitous, whereas other fixed PSTNs are most likely to be limited to particular regions such as CBDs and metropolitan areas. As noted in Chapter 5, the costs of providing services using fixed PSTN services (including the costs of interconnection services) differ across geographic areas. For example, the costs of providing interconnection services in rural areas are likely to be significantly different to those in CBDs. As a result, a national average price will likely be a poor indicator of Telecom's long-run forward-looking costs of providing interconnection services in areas where other fixed PSTN providers are likely to enter. Consequently, basing charges for interconnection with other fixed PSTNs on Telecom's national average price is likely to generate inefficient signals for entry.

485. The answer however is not necessarily to estimate TSLRIC separately for other fixed PSTN providers. The best way to address this problem is to set prices for interconnection with Telecom's fixed PSTN that reflect differences in costs across regions. In this way interconnection prices set the proper target for potential providers of fixed PSTN services to beat.

Differences in the network level at which interconnection is provided

486. A second potential source of difference between the interconnection services provided by Telecom and other fixed PSTN providers is the level in the network at which interconnection is provided. For example, Telecom may offer interconnection at its local switch, whereas other fixed networks may offer interconnection at the equivalent of Telecom's tandem switch. The costs incurred in providing these interconnection services will differ. In this case, the price of interconnection with other fixed PSTNs should be set on the basis of the price the Commission would set for Telecom if it provided

interconnection at the equivalent network level.[93] In the example above, this involves setting interconnection charges on the basis of Telecom's long-run forward-looking costs of providing interconnection at the tandem switch.

Differences in the types of traffic

487. A third possible source of difference is the types of traffic provided on different networks. Likely to be of particular importance in this regard is the proportion of calls to internet service providers (ISPs). The costs of terminating calls to ISPs have different characteristics to the cost of terminating voice calls. As a result, basing charges for terminating calls to ISPs on an average of the costs of terminating voice and data calls using Telecom's fixed PSTN is unlikely to provide efficient investment signals. However, a number of points should be kept in mind.

488. First, the Commission may not be required to set terminating charges for calls to ISPs. As noted in the *Interconnection Methodology Paper*, the Commission is inclined to use a bill and keep methodology to set these charges.

489. Second, if setting cost-based prices for calls to ISPs is required, the best approach is likely to be to do so on the basis of the long-run costs of terminating such calls based on Telecom's forward-looking network design. Again this will provide the appropriate cost target for new entrants to beat.

It is the Commission's preliminary view that charges for interconnection with fixed PSTNs other than Telecom's should **in principle** be based on the price determined by the Commission for interconnection with Telecom's fixed PSTN. The Commission recognises however, that for such an approach to provide efficient investment signals, the interconnection services provided on each of the networks must be similar. As a result, **in practice**, it will, in some cases, be necessary to determine different charges for interconnection with Telecom's fixed PSTN by:

- geographic region;
- the location in the network interconnection occurs; and
- the type of traffic.

The Commission seeks comments on this approach. The Commission is particularly interested in any practical difficulties with this approach.

[93] This does not mean that the other network provider need provide interconnection using the same combination of network elements as Telecom.

13. Duration of Commission's determinations

490. Under the Act, the Commission will be required to determine interconnection prices on the basis of TSLRIC only where either the access provider or the access seeker asks the Commission to revise an (initial) determination. Commission determinations of interconnection prices are likely to be at sporadic intervals and for different access seekers. There are two related issues in relation to the duration of the Commission's determinations. One is how the Commission may determine charges over a period extending beyond one year. The other is how to ensure consistency among determinations over time and across access seekers.

13.1. Setting charges over the duration of the determination

491. For a determination made for more than one year, the Commission proposes to set a price path. The price in each year of the determination will reflect changes in forward-looking costs from one year to the next.

492. For network and non-network capital costs this is relatively straightforward. Capital costs will be determined in accordance with the tilted annuity. In doing so the capital costs will change from one year to the next at the same rate as changes in the replacement cost of the assets.

493. Estimating changes in network and non-network O&M costs over time is not as straightforward. There are two possible approaches. One approach is to change these costs from one year to the next based on changes in the replacement cost of the capital equipment. This is consistent with the approach to estimating these costs in the first instance.[94] The other approach is to estimate yearly changes in these costs based on changes in the costs of labour and materials and changes in labour productivity. This could be based on labour cost and productivity indices for the telecommunications industry (if appropriate indices exist).

For determinations of interconnection prices for more than one year the Commission proposes to set a price path. The price path will reflect estimated changes in capital and O&M costs over time. The Commission proposes to estimate changes in capital costs over time based on the tilted annuity. The Commission seeks comments on the two approaches listed above for estimating changes in O&M costs over time.

[94] As noted in Chapters 9 and 10, network and non-network O&M costs are initially to be estimated as percentages of the values of network and non-network capital equipment.

13.2. Consistency between Commission determinations

494. A primary consideration of the Commission is to ensure consistency between determinations. Say the Commission makes a determination for a particular access seeker for say four years, and two years later another access seeker seeks the Commission to make a determination of the price for the same interconnection service. It is desirable that the prices at that point of time be the same (or very similar) for both access seekers.

495. If the second determination is made on the basis of the price path set in the first determination, the prices will be the same. If however the Commission changes any of the inputs in the cost model the prices will diverge. These include changes in the return on funds, a re-optimisation of the technology and assets used to provide the services, the volume of services provided and so on.

496. The Commission faces a trade-off. Ensuring the consistency of determinations over time will eventually result in interconnection charges that do not reflect forward-looking costs. There are two related issues here. One is how frequently the Commission should alter the inputs to the model. The second is the duration of determinations. The more frequently the inputs to the model are altered over time, the greater the likelihood of inconsistencies between access seekers and the shorter should be the duration of the Commission's determinations.

The Commission seeks views on the:

- appropriate duration of Commission determinations;

- frequency with which it should alter inputs to the model such as the return on funds; and

- frequency with which it should re-optimise the model.

In making these comments the Commission encourages parties to consider the implications for ensuring consistency in determinations over time.

Appendix 1: Full definition of Brennan-Lally CAPM

497. The Brennan-Lally model of CAPM is defined as follows:

$$r_e = t_{div} Div + r_f (1 - t_{\text{int}}) + \beta_e (Post\ Tax\ Market\ Risk\ \text{Pr}emium)$$

where

r_e is the return on equity;

t_{div} is the weighted average effective tax rate on dividends for all investors - defined as the weighted average over investors of $\frac{(T_{di}^j - T_{gi})}{(1 - T_{gi})}$

where T_{di}^j is investor *i*'s marginal tax rate on dividends from company *j* (accounting for the dividend imputation scheme) and T_{gi} is investor *i*'s marginal tax rate on capital gains;

Div is the dividend yield on risky asset j (equal to the cash dividend (DIV_j) divided by the dividend price (S_j));

r_f is the risk free rate of return;

t_{int} is the weighted average effective tax rate on interest for all investors - defined as the weighted average over investors of $\frac{(T_{Ii} - T_{gi})}{(1 - T_{gi})}$

where T_{Ii} is investor *i*'s marginal tax rate on interest income and T_{gi} is investor *i*'s marginal tax rate on capital gains;

β_e is the equity beta;

$$Post\ Tax\ Market\ Risk\ \text{Pr}emium = r_m - r_f (1 - t_{\text{int}}) - t_{divm} Div_m$$

where

r_m is the expected level of return on the market portfolio of risky assets;

t_{divm} is the weighted average over assets of t_{div}; and

Div_m is the dividend yield of the market portfolio (equal to the market cash dividend (DIV_m) divided by the market dividend price (S_m)).

498. Lally goes on to show that t_{div} and t_{divm} can be redefined as follows:[95]

$$t_{div} = t_{\text{int}} - U(1 - t_{\text{int}})\frac{IC_j}{DIV_j}$$

$$t_{divm} = t_{\text{int}} - U(1 - t_{imt})\frac{IC_m}{DIV_m}$$

where

IC_j is the imputation credits attached to company *j*'s cash dividend DIV_j;

U is the weighted average of investors' utilisation rates for IC_j (value between 0 and 1); and

IC_m is the imputation credits attached to the market's cash dividends DIV_m.

499. Hence, estimating the value of t_{div} and t_{divm} would depend on:

- investors' marginal tax rates on dividends and capital gains;
- the extent to which imputation credits are attached to dividends; and
- the value to investors of imputation credits on dividends.[96]

500. It has been common practice in New Zealand (including by the Commission) to apply the Brennan-Lally CAPM with a simplifying set of assumptions:

- the value t_{div} is zero, i.e., dividends are tax free as they are assumed to be fully imputed and investors are able to fully utilise the credits;[97]

[95] Lally, M., *The Cost of Equity Capital and Its Estimation*, MacGraw Hill Series in Advanced Finance, Volume 3, 2000, p.6.

[96] Lally, M., *The Cost of Equity Capital and Its Estimation*, MacGraw Hill Series in Advanced Finance, Volume 3, 2000, p.6. and Bowman, R.G and Marsden, A, "Cost of Capital Under Imputation: An Analysis of Comparative Models", *New Zealand Investment Analyst*, 1996, p.28.

- the average investor faces a 33% marginal tax rate on interest;
- capital gains are not taxed; and
- hence, t_{int} is 33%.[98]

501. These assumptions result in a considerably simplified Brennan-Lally model expressed as follows:

$$r_e = r_f\left(1 - t_{\text{int}}\right) + \beta_e\left(Post\,Tax\,Market\,Risk\,\text{Pr}\,emium\right)$$

where $Post\,Tax\,Market\,Risk\,\text{Pr}\,emium = r_m - r_f\left(1 - t_{\text{int}}\right)$.

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[97] $t_{div} = t_{\text{int}} - U\left(1 - t_{\text{int}}\right)\frac{IC_j}{DIV_j}$. If maximum imputation credits are attached to dividends, $\frac{IC_j}{DIV_j} = 0.33/0.67 = 0.495$, if investors can fully utilize the credits then U=1 and it is assumed that $t_{\text{int}} = 0.33$, then $t_{div} = 0.33 - 1\left(1 - 0.33\right)\frac{0.33}{0.67} = 0$

[98] Commerce Commission, *Price Control Study of Airfield Activities at Auckland, Wellington, and Christchurch International Airports*, Draft Report, p. 113.