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COMMERCE COMMISSION

Draft Determination for TSO Instrument for Local Residential Telephone Service for period between 1 July 2005 and 30 June 2006

Determination under section 90 of the Telecommunications Act 2001 ('the Act') of matters set out in section 92 of the Act in the matter of Telecommunications Service Obligations for Local Residential Service, for the period 1 July 2005 to 30 June 2006 being the financial year of the Telecommunications Provider 'TSP', Telecom New Zealand Limited.

The Commission	Douglas Webb Donal Curtin Gowan Pickering

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LIST OF TERMS AND ABBREVIATIONS

For the avoidance of doubt, the definitions in the Act or TSO Deed have precedence over the definitions in this document.

Abbreviation/ Term	Explanation
ACCC	Australian Competition and Consumer Commission
Access Network	the network that connects customers to their local telephone exchanges
ADSL	Asymmetric Digital Subscriber Line. A technology for transmitting digital information at high bandwidths on phone lines
BH, bh	Busy Hour – the hour at which a system e.g. an exchange is at its busiest i.e. is handling the maximum traffic
CAPEX	capital expenditure
CAPM	Capital Asset Pricing Model
CCS 7, CCS#7, SS7 Common Channel Signalling Version 7	a network standard that transmits call-handling information for telecommunications calls over a separate channel than that taken by the calls.
CDMA	a digital mobile phone technology known as Code Division Multiple Access
Cluster	a group of customers connected to the same feeder cabinet or directly to an exchange
CNVC	commercially non-viable customer – a Telecom residential customer in respect of whom the efficient incremental cost of providing the TSO services exceed the standard residential line rental plus expected supplementary revenues.
Core Network	the network that connects the customer serving exchanges
CostProNZ	CostPro New Zealand Model is the application used to model the core network and transmission system costs
CRA	Charles River Associates International
CSD	GSM: Circuit Switched Data
CT	Cable Terminal

Abbreviation/ Term	Explanation
DLC	Digital Loop Carrier
DMR	fixed radio trunking technology known as Digital Microwave Radio
d-side	distribution side; the side of a cabinet and its network closest to the customer
DSLAM	Digital Subscriber Line Access Multiplexer. A device which takes a number of ADSL subscriber lines and concentrates these to a single ATM line
E1	a 2Mb cable link used for the transmission of telephone calls or data
Erlang	unit of telephone exchange capacity to handle concurrent calls
ESA	Exchange Service Area (also commonly referred to in the United States as a 'wire centre') – this is the exchange area along with its associated customers,.
FCC	The Federal Communications Commission is a United States government agency, charged with regulating interstate and international communications by radio, television, wire, satellite and cable.
Feeder Cabinet	an enclosure used for the termination of cables, wiring and connection devices.
FPDN	Fixed Public Data Network – a public data network using fixed (non radio) access technology.
GPRS	General Packet Radio Service
GSM	a digital mobile phone technology known as General System for Mobile
HAI	Hatfield Model – a core network model
HCPM	Hybrid Cost Proxy Model – an access network model
HSCSD	High Speed Circuit Switched Data (a GSM technology)
IN	Intelligent Network – a system for providing advanced telephony services such as toll free phone calls where the terminating party pays for the calls.

Abbreviation/ Term	Explanation
IP	Internet Protocol – a data transmission protocol
ISP	Internet service provider
LEC	a Local Exchange Carrier in the United States – this is a local telephony company.
LICA	Local Interconnect Calling Area – Interconnect calling area boundaries.
LOS	Line of Sight – a condition where there is an unobstructed or direct path between two points.
LRIC	Long Run Incremental Cost – the additional costs incurred in the long run in supplying a defined increment of output.
MAR	Multi-Access Radio – a wireless access technology.
MDF	Main Distribution Frame – an interface between the lineside of an exchange and the cables providing service to customers directly connected to the exchange.
MEA	Modern Equivalent Asset is the equivalent item of equipment that would be used if an outdated asset in the network were to be replaced, given current best practice.
MJA	Marsden Jacob Associates
MSC	Mobile Switching Centre – the centre where mobile traffic is switched.
MT	Mobile Technology radio cap
Net Cost	the unavoidable net incremental costs to an efficient service provider of providing the service required by the TSO instrument to commercially non-viable customers
NGN	Next Generation Network - the successor to the current circuit switched telephone network (PSTN). This network uses packet switched (IP) data.
NSL	Network Strategies Limited
OFTEL	United Kingdom Office of Telecommunications, now merged into broader regulatory agency Ofcom
OPEX	Operational expenditure

Abbreviation/ Term	Explanation
ORC	Optimised Replacement Cost
PABX/PBX	Private Automatic Branch Exchange – a automated exchange normally used by a business
PHB	PHB Hagler Bailey Asia Pacific Limited
PSTN	Public Switched Telephone Network is a dial-up telephone network used, or intended for use, in whole or in part, by the public for the purpose of providing telecommunication between telephone devices
Required Services	those services the TSP is explicitly required to provide to TSO customers under the terms of the TSO instrument
RF	Radio Frequency
RLU	Remote Line Unit – a remote line concentrator without intra-calling capability
SDH	Synchronous Digital Hierarchy – a method for communicating digital information using light over optical fibre.
Simulation Period	This is a number internal to the TSO program showing the simulation period. (1=2001/2002, 2=2002/2003, 3=2003/2004 etc)
STP	Signalling Transfer Point - is a 'router' that relays SS7 messages between signalling end-points – this is similar to IP but is not the same technology.
T1	A North American standard used to transmit 24 digitised voice grade signals
TDM	Time Division Multiplexing – a means by which 2 or more signals can share a common communication channel by each having a reserved and repeating time to use the channel.
Telecom/TCNZ	Telecom New Zealand Limited / Telecom Corporation of New Zealand
Tilt	the rate of change in the replacement price of network assets
TRX	Transceiver - a unit comprising a transmitter plus a receiver

Abbreviation/ Term	Explanation
TSLRIC	Total Service Long Run Incremental Cost, in relation to a telecommunications service, means: a) 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.
TSO	the obligations prescribed by the Telecommunications Service Obligations Deed for Local Residential Telephone Service between Telecom and the Crown dated December 2001 (the 'TSO Deed')
TSO period	1 July 2005 to 30 June 2006, being the period to which this determination applies.
TSP	Telecommunications Service Provider, which is the entity that delivers the TSO. This is Telecom New Zealand Limited for the TSO period.
TUANZ	Telecommunications Users Association of New Zealand
UCC	User Cost of Capital
USO	Universal Service Obligation
USP	Universal Service Provider
VB	Visual Basic is a computer language
VC++	Visual "C++" is an advanced object orientated programming language
VNZ	Vodafone New Zealand Limited
VoIP	Voice over Internet Protocol. This is a protocol which allows the transmission of digitised voice signals as data
WACC	Weighted Average Cost of Capital
WLL	Wireless Local Loop

EXECUTIVE SUMMARY

Introduction

i.) The Telecommunications Act 2001 regulates the supply of telecommunication services in New Zealand.

ii.) Part 3 of the Act facilitates the supply of certain telecommunications services to groups of end-users within New Zealand who may not otherwise be supplied these services on a commercial basis, or at a price that the Minister considers to be affordable.

iii.) The Commission annually determines the net cost incurred for the supply of the services by Telecom New Zealand Limited ('Telecom') under the TSO Deed. [1] It also determines the allocation of this cost among liable persons in the telecommunications industry, and assesses Telecom's compliance with the TSO Deeds' quality standards.

The Commission's Models

iv.) The Commission has used its own cost models to calculate the net cost for the TSO period. The models use a 'bottom-up'[2] approach to design the network of an efficient telecommunications operator.

v.) Cost caps have been applied where radio solutions are a cheaper means than wire-line of providing the TSO services to commercially non-viable customers. These areas are re-modelled with either mobile, radio local loop or multi-access radio costs.

vi.) The viability of each cluster of residential customers is tested by comparing customer revenues to modelled costs.

vii.) Each year's net cost calculation commences from a core network that was optimised during the 2001/2002 TSO period. Subsequently the Commission models the costs of building an optimised network to connect each customer to the local exchange. The Commission has rejected proposals for more extensive optimisation.

Weighted Average Cost of Capital

viii.) The cost of capital or WACC is an important element in estimating the cost of the TSO. It is the opportunity cost of the funds invested in the network and non-network assets needed to supply the relevant TSO services.

ix.) The Commission has adopted a post-tax WACC of 7.4% for this period.

TSO Processes

x.) The transitional provisions for the TSO determinations under the Telecommunications Amendment Act (No. 2) 2006 provide that the principal Act continues to apply as if those amendments had not been made in respect of TSO determinations that were commenced but not completed before the commencement of the Amendment Act. This determination was commenced before that commencement date. Accordingly the Commission will issue a single determination for the TSO period and not a TSO cost calculation determination and a TSO cost allocation determination.

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[1] The provisions of the TSO Deed require Telecom to provide: basic telephone access as widely available as it was at 20 December 2001; free local calling; dial up internet access; free listing in the White Pages; free genuine 111 emergency calls; and a monthly line rental no higher than the CPI adjusted price of the residential line rental charged at 1 November 1989.

[2] A modelling approach progressing from small or subordinate units to a larger or more important unit.

Liable Persons

xi.) Liable persons (as defined in section 5 of the Act) means (except where they are the TSO provider), Telecom; and a person whose network is interconnected with Telecom's fixed PSTN and who provides a telecommunications service in New Zealand to end users by means of a PSTN. Telecom is the TSO provider in this case and the liable persons are:

- TelstraClear New Zealand Limited;
- Vodafone New Zealand Limited;
- Compass Communications Limited;
- CallPlus Limited;
- WorldxChange Communications Limited;
- TeamTalk Limited;
- ihug Limited; and
- Woosh.

Net Cost Calculation

xii.) For the TSO period, the total net revenues of liable persons and Telecom are $3.955 billion.

xiii.) The Commission's TSO net cost model, at a post-tax WACC of 7.4%, calculates the following cost for the TSO period:

TSO Net Cost	$78.3 Million
Residential CNVCs	58,025

TSO Net Cost Apportionments

xiv.) The TSO net cost is apportioned based on liable revenues as shown on the table below.

Table 1: Reported Carrier Liable Revenues and TSO Charge for Period 1/7/2005-30/6/2006

2005/2006	Liable Revenue ($)	% of total	TSO Charge ($)	Loss of use of money ($)	TSO charge Payable to Telecom ($)
Telecom	2,710,813,000	68.548%	53,640,865	[redacted]	[redacted]
Vodafone	995,896,000	25.183%	19,706,532	TBA	TBA
TelstraClear	227,176,000	5.745%	4,495,300	TBA	TBA
WorldxChange	8,595,729	0.217%	170,090	TBA	TBA
Ihug	8,381,471	0.212%	165,850	TBA	TBA
CallPlus	2,712,960	0.069%	53,683	TBA	TBA
Teamtalk	579,793	0.015%	11,473	TBA	TBA
Woosh	276,157	0.007%	5,465	TBA	TBA
Compass	177,992	0.005%	3,522	TBA	TBA
Total	3,954,609,102	100.000%	78,252,780	TBA	TBA

Compliance with the TSO Deed's Requirements

xv.) In accordance with section 80 of the Act, the Commission is required to make an annual assessment of Telecom's compliance with several basic quality of service standards specified in the TSO Deed. The Commission is satisfied that Telecom has complied in respect of the TSO period.

INTRODUCTION

1. The Telecommunications Act 2001, which regulates the supply of telecommunications services in New Zealand, was recently amended by the Telecommunications Amendment Act (No 2) 2006. In this determination the Commission refers to these statutes as "the Act"[3]. This determination is in respect of the TSO Deed for Local Residential Telephone Service for the period from 1 July 2005 to 30 June 2006.

2. The transitional provision for TSO determinations in section 63 of the Telecommunications Amendment Act (No. 2) 2006 provided that "despite the amendments made by this Act to the principal Act, the principal Act continues to apply as if those amendments had not been made in respect of any TSO determinations that were commenced but not complete before the commencement of this act".

3. The TSO process for 2005/2006 commenced before the Amendment Act. Consequently for the purpose of this determination, the TSO provisions of Part 3 continue to apply as they were prior to the Amendment Act. The Commission will therefore release a single determination for the TSO period.

4. Confidential information in this determination is subject to a confidentiality order made under section 15(i) of the Act and section 100 of the Commerce Act on 23 August 2006. The Order is available on the Commission's website (www.comcom.govt.nz).

5. The Order prohibits the disclosure of confidential information during the 2005/2006 TSO proceeding except where approved counsel and experts of interested parties have signed a deed of undertaking as to confidentiality and are approved to access the confidential information in accordance with the Order. Confidential information is referred to as Restricted Information under the Order (except where clause 4 applies and the information is granted Commission only status) and is identified by square brackets in the determination, ([ ]) or in the "comments" field of particular tables in the determination. All confidential information has been extracted from the public version of the determination.

6. In some cases the Commission has redacted entire tables from the public version of the determination. Due to formatting difficulties, the Commission is unable to produce a version of the tables which only identifies the numbers as Restricted Information. Where the Commission has removed an entire table from the decision, please note that the only information that is classified as Restricted Information under the Order is the numbers in those tables.

7. The Restricted Information in the determination includes a mixture of data which the Commission has received from interested parties to this determination, other third parties, and where, possible data derived by the Commission from data sourced from those parties. All Restricted Information in this determination is Commission Restricted Information except where the Commission has specifically identified beside the brackets ([ ]) that the information is party designated Restricted Information, for example, TelstraClear-designated Restricted Information ('TCRI'), Vodafone-designated Restricted Information ('VNZRI'), TeamTalk-designated

[3] All terms and phrases that are defined within the Act have the same meanings in this determination unless otherwise stated. All references to Parts, schedules and sections are to the Parts, schedules and sections of the Act.

Restricted Information ('TTRI') or Telecom-designated Restricted Information ('TCNZRI'). However, the latter classifications are exceptions and all other Restricted Information in the determination is Commission Restricted Information.

TSO PROCEEDINGS

8. Under Part 3 of the Act, the Commission is required to determine the net cost incurred for the supply of the services required by the declared TSO instruments, the allocation payable by all liable persons and the measurement of compliance to the specified standard.

The TSO Deed for Local Residential Telephone Service

9. The Act requires the Commission to determine, on an annual basis, the net cost incurred by the TSP in providing the services required to meet its obligations under the TSO Deed for local residential telephone service.

10. The TSO Deed requires Telecom, as the TSP, to:

    - maintain a free local-calling option for all residential customers, for both voice and data calls;
    - maintain, in real terms, the standard rental for residential customers at or below the level charged on 1 November 1989;
    - charge residential customers in rural areas no more than the standard residential rental;
    - continue to provide local residential telephone services as widely available as it was at December 2001;
    - continue to provide directory assistance on the basis set out in the exchange of letters between the Crown and Telecom in 1997; and
    - meet a number of service quality measures in areas including unsuccessful call attempts, complete switch downtime and the connection speed for standard dial up internet calls.

The Framework for the Determination

11. This section outlines the legislative framework for TSO instruments under Part 3 of the Act and the Commission's responsibilities with regard to these instruments.

12. Section 70(1) explains the purpose of the declaration of TSO instruments:

    > The purpose of this section is to facilitate the supply of certain telecommunications services to groups of end-users within New Zealand to whom those telecommunications services may not otherwise be supplied on a commercial basis or at a price that is considered by the Minister to be affordable to those groups of end-users.

13. The TSO Deed was declared as a TSO instrument under section 70(2) in 2001.

14. Subpart 2 of Part 3 of the Act prescribes the annual procedure for determining the net cost of the TSO and the amounts payable by liable persons to the telecommunications service provider ('TSP') as a contribution towards this cost.

15. The Commission is required under section 80 to make an annual assessment of a TSP's compliance with a TSO instrument.

16. Section 81 requires that every liable person provide the financial and other information specified by the Commission. Section 83 requires the TSP to provide to the Commission a calculation of the net cost to it of complying with the TSO, along with an auditor's report confirming the calculation.

17. Section 84(1) requires that the Commission take the following matters into account in calculating the TSO net cost:

    (a) the range of direct and indirect revenues and associated benefits derived from providing telecommunications services to commercially non-viable customers, less the costs of providing those telecommunications services to those customers:

    (b) the provision of a reasonable return on the incremental capital employed in providing the services to those customers.

18. The 'net cost' (of the TSO) is defined in section 5 as:

    ... the unavoidable net incremental costs to an efficient service provider of providing the service required by the TSO instrument to commercially non-viable customers.

19. Section 84(2) states that in determining the net cost under section 92, the Commission:

    (a) may choose to not include profits from any new telecommunications services that involve significant capital investment and that offer capabilities not available from established telecommunications services; and

    (b) must not include any losses from telecommunications services other than services that the TSO instrument requires the TSP to provide; and

    (c) must consider the purpose set out in section 18.

20. The purpose described in section 18 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.

21. Section 90 requires the Commission to make a final determination of the matters set out in section 92. As the TSO instrument does not specify the total amount payable by all liable persons to the TSP, the Commission is required to include all the relevant information outlined in section 92 in its final determination. Therefore, the final determination must include:

    (a) … (i) the net cost to the TSP of complying with the TSO instrument during the TSP's financial year and all material information that—

    (A) relates to the calculation of the net cost; and

    (B) would not, in the opinion of the Commission, be likely to unreasonably prejudice the commercial position of the TSP; and

    (ii) the amount of revenue determined in accordance with any prescribed methods that the TSP receives during the financial year from providing telecommunications services either by means of its PSTN or by means that rely primarily on the existence of the TSP's PSTN; and

    (b) … (i) the amount of revenue that each liable person in relation to the TSO instrument receives during the TSP's financial year from providing telecommunications services either by means of its PSTN or by means that rely primarily on the existence of the TSP's PSTN; and

    (ii) the amount (if any) by which the total amount that the TSP would receive from all liable persons in relation to the TSO instrument must be reduced because the TSP has not complied with the TSO instrument; and

    (c) a statement that identifies which revenue basis has been used under section 85(1) in respect of each amount of revenue to which the final determination applies; and

    (d) if a weighted revenue basis has been used for any amount of revenue, the particulars of the weighting attached to that amount of revenue; and

(e) the revenue amounts that will be used for the purposes of calculating, under section 93, the amount payable by each liable person in relation to the TSO instrument; and

(f) an amount payable by each liable person in relation to the TSO instrument to the TSP in respect of the financial year calculated in accordance with section 93; and

(g) an amount payable by each liable person in relation to the TSO instrument to the TSP for the loss of use of the amount referred to in paragraph (f) calculated at the 90-day bank bill rate (as at the date of the final determination) for the period commencing from the end of the TSP's financial year and ending with the date of the final determination.

IDENTIFYING THE NET COST OF THE TSO

22. In order to determine the net cost of the TSO, the Commission has interpreted a number of key terms, including:

    i. unavoidable net incremental cost;

    ii. Commercially Non Viable Customers ("CNVC"); and

    iii. an efficient service provider.

Unavoidable Incremental Cost

23. The concept of incremental cost is well established in economics. It is the additional cost a firm would incur if it chose to serve an extra customer or group of customers, or provide an extra unit or tranche of output.[4] It is often useful to think of this in terms of the difference in a firm's costs 'with' and 'without' the additional customer(s) or unit of output. Incremental costs do not include common costs.

24. In the context of the TSO, the incremental cost of an obligation to provide services to commercially non-viable customers is, therefore, equal to the difference in the firm's total costs between the circumstances where it supplies those customers in conjunction with all its other customers, and where it does not.

25. In respect of the access network, the relevant increment will be the access costs associated with serving CNVCs. In terms of the core network, the relevant increment will be the total tranche of calling costs associated with the CNVCs.

26. In estimating the net cost of the TSO, the Commission regards unavoidable net incremental costs as the difference between the long-run costs an efficient service provider would incur with and without the obligations imposed by the TSO instrument. This includes a return on incremental capital required to meet the obligations under the TSO instrument, as well as appropriate depreciation costs of those assets.

27. The unavoidable net incremental cost should be the long run incremental cost (LRIC). The long run is a period of time of sufficient duration for the firm to be able to alter all inputs to the service. This means that long-run costs include the costs of all the inputs used to provide the particular service.

Commercially Non-Viable Customers

28. The TSO unavoidable net incremental cost is essentially the cost of providing TSO services to CNVCs.

29. CNVCs are, those groups of customers in respect of whom the efficient incremental costs of providing the TSO services exceed the standard residential line rental plus expected supplementary revenue.

30. The Commission considers that Telecom would, in the absence of the TSO, have set residential access prices on an aggregated basis to groups of customers, and not on an individual basis.

31. The Commission considers that the smallest group of residential customers served by a fixed line access network to which costs ought to be attributed is a cluster; that is, the group of customers connected to the same feeder cabinet or directly to an

[4] See, for example, Baumol, W and Sidak J, *Toward Competition in Local Telephony*, 1994, p. 57.

exchange. The bulk of the costs of serving such customers are shared capital costs, such as trenching of distribution cables, and most of the cost sharing takes place between some or all of the customers in the same cluster. While it is arguable that Telecom would not price discriminate at so fine a geographic level, the Commission considers that this approach is consistent with Telecom's observed tendency to price discriminate at a level above the individual customer.

32. Where customers are served by a fixed radio network, the group or cluster will take on a different form because of the different cost structures of these networks.

33. The demand for basic telephone access is highly inelastic. It is therefore very unlikely that a material number of customers would voluntarily disconnect as a result of a rise in prices on a broad geographic basis. The Commission therefore considers that, in the absence of the TSO, there would be very few residential customers that would not be supplied, or would not take supply, at any plausible price above the TSO CPI indexed rental price cap.

34. In order to allow Telecom to earn a reasonable return on supplying service to CNVCs, as required by the Act, the Commission considers that the appropriate manner in which to identify CNVCs and calculate the amount Telecom should be able to recover is to assume that Telecom continues to serve all its customers, and to ask:

    i. If an efficient service provider was to provide service to all Telecom residential customers connected at 20 December 2001:

    ii. for which clusters of residential customers would the incremental economic costs of providing the TSO services exceed the standard residential line rental plus expected supplementary revenue?; and

    iii. by how much would that cost exceed that revenue?

35. CNVCs are identified and costed on a cluster basis. This means that each cluster generated by the cost modelling has been identified as either viable (able to be viably supplied at the cost cap) or non-viable (not able to be viably supplied at the cost cap). The sum of the net costs of all the non-viable clusters is the total TSO net cost.

Efficient Service Provider

36. The term "efficient service provider" is referred to in the definition of "net cost" as ... the unavoidable net incremental costs to an efficient service provider of providing the service required by the TSO instrument to commercially non-viable customers.

37. The determination of the unavoidable net incremental costs is dependent on the interpretation applied to the term "efficient service provider".

38. The meaning of "efficient service provider" is not defined in the Act. Section 5 of the Interpretation Act 1999 requires the meaning of an enactment to be ascertained from its text and in the light of its purpose.

Context

39. The main purpose of the Act is to regulate the supply of telecommunication services.

40. Under section 70(1) of the Act, TSO instruments are declared to facilitate the supply of certain telecommunication services to groups of end-users within New Zealand to whom those telecommunications services may not otherwise be supplied on a commercial basis or at a price that is considered by the Minister to be affordable to those groups of end users.

41. The TSO Deed is primarily an instrument of social policy. It recognises that there are some high cost customers for whom a basic social need (basic telephony and internet services) would not be met without a subsidy. The Commission determines the amount of that subsidy, and allocates it across Telecom and liable persons.

42. The TSO provisions of the Act are not designed primarily to have an effect on competition. However, the Commission must have regard to potential effects on competition. In determining the "net cost" of the TSO, the Commission is directed by section 84 to consider a number of matters, including the purpose set out in section 18 of the promotion of competition in telecommunications markets for the long-term benefit of end-users of telecommunications services within New Zealand. Section 18 also requires the Commission to consider efficiencies.

Relevant standard of efficiency

43. Any modelling undertaken by the Commission to determine unavoidable net incremental costs in this context must reflect the costs of an efficient service provider.

44. The reference to an "efficient service provider" standard does not in itself produce a single definitive approach that is free of controversy. Submissions before the Commission in the TSO process have advocated contrasting approaches, ranging from use of the TSP's actual historic costs as the key reference point to disregarding all of these costs, and instead using the costs of a hypothetical efficient service provider.

45. An efficient service provider could be defined as one who produces a given quantity and quality of service for the lowest possible cost. The desirable level of efficiency could also be determined by reference to a competitive market, where incentives operate to ensure that costs are minimised over time. However, the Commission considers that imposing the highest standard of efficiency possible is unreasonable, particularly in the context of assessing the cost of a social policy obligation. For example, the concept of a perfectly contestable market, in which entry and exit is costless is unlikely to be appropriate in the current context.[5]

46. While the Commission has regard to the above reference points, this is qualified by other efficiency considerations. In particular, the Commission considers that it would be unreasonable to impose a standard of efficiency that completely disregarded the costs of the TSP, and that doing so could in itself give rise to inefficiencies.

47. The choice of the efficient service provider standard appears to be designed to limit the recovery of inefficient costs associated with historical monopoly provision of local access services. This also provides incentives for the TSP to minimise costs and invest efficiently.

48. While it is appropriate to depart from the actual costs faced by the TSP, the Commission considers that the TSO costing exercise should still have some regard to these costs. Other efficiency considerations are also important in this context – if investments that appeared prudent at the time cannot be recovered because of inappropriately restrictive regulatory settings, then this could create a strong disincentive to further investment.

[5] If entry and exit were costless (i.e. there are no irrecoverable costs), 'hit-and-run" entry would be feasible where potential entry would occur whenever prices exceeded costs. In the context of the TSO, this would suggest that the TSO could be tendered on a short-term basis, for example each year (or even shorter), and that parties would be willing to enter and invest despite the short timeframe, because exit is by definition free. At the extreme, the existing TSP could be replaced instantaneously by a challenging TSP, whenever the challenger could provide the services at a lower cost. The incumbent TSP would be able to costlessly exit the "market".

Specific modelling approach

49. In determining the TSO net cost, the Commission has modelled the costs to an efficient service provider of providing the services required by the TSO Deed to commercially non-viable customers.

50. A modelling approach involving the complete reconstruction of a network annually without reference to any historic investment decisions is referred to as 'scorched earth' or 'green fields' modelling. At the other extreme, costs can be based on those of an existing legacy network. An intermediate position involving the retention of a core network plus the imposition of a periodic optimisation of the access network is referred to as 'scorched node' modelling.[6]

51. A scorched node modelling approach has often been adopted by regulators in other jurisdictions. For example: [7]

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

52. The Commission has adopted the scorched node approach. This approach limits the recovery of inefficient costs, maintains reasonable pressure for cost minimisation, but also allows the TSP some scope to recover a reasonable level of cost incurred in fulfilling a social policy obligation. The approach recognises that the evolution of an efficient network design is restricted to some extent by past investment decisions.

53. The Commission considers that this approach is consistent with the promotion of competition for the long term benefit of end users. While the modelled costs under this approach may be higher for Telecom's competitors, the level of cost borne by Telecom also increases proportionately. In that sense, the outcome is competitively neutral. The Commission has also taken efficiency considerations, noted above, into account.

54. Under the scorched node approach, the Commission has retained the TSP's core network topology and technology after performing a limited amount of optimisation in the first year.[8]

55. The Commission considers that its scorched node approach preserves incentives to invest in the access network and limits regulatory stranding of assets. Over time, however, technological change and services providers own commercial strategies can lead them to strand legacy assets by replacing them with newer assets. If in the future the Commission observes that Telecom has modified its core network architecture, the Commission may consider removing the existing nodes in the TSO model and updating the modelled technology.

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[6] Nodes exist in a telecommunications network where the switching function occurs; to this extent, in the TSO context, they are synonymous with exchanges. The term 'node' places emphasis on the network topology while 'exchange' places emphasis on its function. Each exchange has a catchment area of its customers the Exchange Service Area ("ESA")

[7] ICT Regulation Toolkit, http://icttoolkit.infodev.org/en/Section.2092.html (7 June 2007). In addition, the Independent regulators Group (IRG) considers a scorched node approach to represent best practice. See IRG http://irgis.anacom.pt/site/en/conteudos.asp?id_conteudo=618&id_l=274&ln=en&id_area=277&ht=Documents

[8] Equipment at nodes were optimised (such as replacing small switches with RLU); and some nodes with a small number of lines were removed. This has in effect provided a 'modified scorched node' as there has been a limited amount of optimisation in 'year 1' that has not been repeated in subsequent years.

56. The Commission has annually modelled an efficient access network capable of delivering the required level of TSO services. Competing technologies have also been considered on an annual basis, including cellular technologies such as GSM. The technologies that have been selected are mature technologies already deployed on a large scale that may have been developed to be compatible with Telecom's network. These competing technologies are applied to clusters of customers. If the cost to serve a cluster is greater than the cost of an applicable competing technology, modelling proceeds using the less expensive competing technology. This has been done in such a way as to preserve the Commission's scorched node assumption.

57. The scorched node paradigm requires any optimisation of the access network to be integrated with Telecom's current network nodes. In these circumstances, replacement access technologies will have to be cost effective in delivering services as a supplement to the modelled core network. In particular, optimisation relying on economies of scale or low incremental costs derived from existing mobile networks to lower costs will not be accepted by the Commission.

58. The Commission does not consider that efficient costs of access networks should reflect those of the overlay mobile networks. Such an approach would, in effect, resemble the outcomes of a perfectly contestable tender process for delivery of the TSO. The Commission will accept the lowest cost technology consistent with the scorched node approach.

Telecom's Obligation to Serve Residential Customers

59. To calculate the net cost to Telecom of complying with the TSO Deed, the Commission must determine the nature of the obligations which the TSO Deed imposes on Telecom to serve new residential customers. Section 70(4) requires a TSO instrument to specify various requirements, including the geographical area in which the service must be supplied.

60. Principle 3 of the TSO Deed states that "The line rental for local residential telephone service for Telecom residential customers in rural areas will be no higher than the standard residential rental and Telecom will continue to make local residential telephone service as 'widely available' as it is at the commencement date." The Commission considers the requirement to make the service as widely available as it was at the commencement date as requiring that the TSO cost calculation be based on the customer demand for local residential telephone lines that existed at the time that the Deed was signed in December 2001. This demand has been used since the 2001/2002 determination.

Intangible Benefits

61. There may be benefits that accrue to Telecom as a result of being the TSP. These would constitute part of the range of direct and indirect revenues and associated benefits derived from providing telecommunications services to CNVCs which the Commission is required to take into account in making the TSO net cost calculation under section 84(1)(a). Such associated benefits can be described as intangible benefits.

62. Previous studies undertaken for telecommunications operators and regulatory bodies[9] have identified a number of potential sources of intangible benefits, the most important being:

- **Ubiquity benefits**: These are benefits arising from the TSP having a ubiquitous network. Two main sources are usually identified for ubiquity benefits:
  - customers moving from commercially non-viable to commercially viable areas where competition exists are more likely to choose the TSP than any of its competitors; and
  - the TSP is likely to attract customers who require services in both commercially viable and commercially non-viable areas and prefer to have a single supplier (e.g. businesses with a presence in commercially non-viable areas).
- **Life-cycle benefits**: These are benefits arising from the fact that customers who are currently commercially non-viable may at some future date become commercially viable, and may then choose the TSP over competitors;
- **Brand name and reputation benefits**: These are benefits arising from an enhancement of brand value and corporate reputation as a result of being the TSP;
- **Access to market information**: These are benefits arising from being able to collect information from a larger sample of customers and a wider range of areas; and
- **Volume discounts**: These are benefits related to the fact that being the TSP provider will generally increase its volumes and thus its bargaining power relative to, for example, equipment providers.

63. The Commission considers intangible benefits, such as those mentioned above, can only arise from the TSP providing service to those customers who would not have been provided with service if it were not for the TSO. As explained previously, the Commission's view on this issue is that very few, if any, extra customers are provided with service because of the existence of the TSO. Accordingly, the intangible benefits Telecom receives from being the TSP must also be nil or very small, and immaterial in the context of the TSO net cost calculation.

64. The Commission's view is that the magnitude of intangible benefits is not significant in terms of the total TSO net cost, and that estimating the size of any intangible benefits the TSP receives is difficult, expensive and subject to error.

Replacement Revenues

65. Section 84(1)(a) requires that "all…associated benefits derived" be taken into account. The concept of replacement revenue is that in the absence of the TSO, the TSP may not supply particular residential households with a fixed line connection but may still earn some revenue from these households from, for example, calls from a

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[9] See, for example, Wissenschaftliches Institut für Kommunikationsdienste (October 1997), *Costing and financing universal service obligations in a competitive telecommunications environment in the European Union*; Wissenschaftliches Institut für Kommunikationsdienste (April 2000), *Study on the re-examination of the scope of universal service in the telecommunications sector of the European Union, in the context of the 1999 Review*; Oftel (July 1997), *Universal Telecommunications Services*; and Australian Communications Authority (January 2000), *Estimate of net universal service costs for 1998/99 and 1999/2000.*

mobile phone, a neighbour's landline or a phone box. In the calculation of the net TSO cost, this notional revenue could be used to reduce the supplementary revenue that the TSP earns from serving CNVCs.

66. However, as mentioned above, in the absence of the TSO it is assumed that almost all residential customers would still be provided with service. Under such assumptions there can be no replacement revenue. Even if a small number of CNVCs would have voluntarily disconnected, had there been no TSO, the consequential replacement revenues would be so small and uncertain as to be immaterial in the context of the net TSO cost calculation.

Revenue from Supplementary Services

67. Supplementary revenue is made up of revenue streams, other than the access rental, that depend on the existence of the residential access line. These revenue streams include but are not limited to those derived from: dial-up Internet access, tolls, and call charges.

68. Section 84(1)(a) requires net revenue derived from providing supplementary services to CNVCs to be included in the TSO net cost calculation. Supplementary revenue is the direct and indirect revenue derived from providing telecommunications services to CNVCs, less the costs of providing those services to those CNVCs. The costs to be subtracted from the supplementary revenue derived from CNVCs are those necessarily incurred in serving CNVCs. In other words, an incremental cost basis should be used and costs that would be incurred in providing those services to the entire customer base, such as advertising and billing system fixed costs, should not be deducted.

69. A similar principle applies to the return on incremental capital employed in providing services to CNVCs that also has to be taken into account under section 84(1)(b). Only the extra capital (if any) required to provide the services to CNVCs should be taken into account.

70. There are large fixed and common costs of owning and running the core network and other infrastructure used for providing supplementary services. As a result, a large portion of supplementary revenue could be expected to be an incremental benefit to Telecom. Since gross supplementary revenue is on average a significant amount, the method of calculation of net supplementary revenue is an important consideration.

71. However, in some cases the revenue may not exceed the cost of the provision of a service. Where this is the case, neither the cost nor the revenue associated with the non-profitable service should be taken into account.

72. The Commission received from Telecom, a list of revenue values by service type for each ESA. The Commission has compared these revenues against the cost of provision of these services and found that all of the types of supplementary service earn an economic profit. Telecom modelled the profitability of Telecom Mobile and Xtra, in each case reflecting a WACC supplied by the Commission. Both earned an economic profit. Accordingly, the costs and revenues of all these services are included in the model.

Cost of Telephone Book Listing

73. As part of its TSO obligations Telecom is required to supply a single standard listing of each Telecom residential customer's local telephone number in the telephone book, also known as the White Pages.[10]

74. The Commission considers that Telecom's listing of CNVCs in its White Pages is not a net cost to Telecom. If the costs of listing extra customers in the White Pages outweighed the benefits then it could be expected that Telecom would charge other suppliers for listing their customers in the White Pages.

75. The Commission considers there is a benefit to Telecom in listing the numbers of all CNVCs in its White Pages; otherwise the White Pages would lose its value as a universal PSTN directory. Since the White Pages are a Telecom-branded product, there is a benefit to Telecom to be the sole universal landline directory in New Zealand. This benefit is demonstrated by Telecom not charging either TelstraClear or resellers of access lines to list their customers in the White Pages.

Cost of 111 Emergency Calling Service

76. As part of its TSO obligations, Telecom supplies free genuine 111 calls to emergency service centres when they are dialled by Telecom residential customers.

77. The annualised capital cost of extra equipment needed in an ESA to support the provision of 111 calls is taken into account in the Commission's cost modelling. The incremental costs of providing the 111 service to CNVCs are the non switching-related variable costs of providing the 111 service. The only cost of this nature appears to be the call centre operator's volume related costs for genuine calls. From the figures previously supplied by Telecom to the Commission, the Commission considers that this cost is much less than one dollar per customer per year, and is therefore not material.

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[10] The White Pages is now also available online.

ASSET VALUATION

78. In order to estimate the unavoidable net incremental cost of providing TSO services, the Commission must determine the value of the assets used to provide those services. The Commission's choice of asset valuation methodology primarily reflects the interpretation of the costs incurred by an efficient service provider providing the service required by the TSO Deed to commercially non-viable customers.

79. Asset valuation is an important exercise in measuring the net cost of the TSO, as it forms the basis for determining capital-related costs. In an industry characterised by a high level of capital intensity such as telecommunications, both the return of capital (depreciation) and the return on capital are significant cost components.

80. The Act states that the calculation of the net cost should take into account 'the provision of a reasonable return on the incremental capital employed in providing the services to those customers'.[11]

Choice of Valuation Methodology

81. The Commission considers that it is appropriate to value TSO assets on the basis of replacement cost. The use of replacement cost as an asset valuation methodology is consistent with the matters it is required to consider in determining the unavoidable incremental net cost of the TSO, and the requirements of the purpose statement set out in section 18.

82. The Commission has adopted a scorched node approach to the optimisation of the network. This optimises the geographical placement of the local access network assets.

83. In terms of the assets themselves, the Commission has taken the position that within a forward-looking network, a modern equivalent asset ('MEA') is the equivalent item of equipment that would be used if an outdated asset in the network were to be replaced given current best practice. The Commission will only consider asset technologies that are fully developed and can be deployed on a large scale. For example, for this TSO period, the Commission does not consider that carrier grade voice-over-IP network assets were fully developed and deployable on a large scale for residential users.

84. Given the adoption of tilted annuity depreciation methodology discussed below, the Commission has valued TSO assets on the basis of optimised replacement cost ('ORC').

Depreciation

85. The rate of depreciation determines the rate at which the costs of an investment are recovered over time. For example, if the TSP invests $10m in copper cable to provide services to TSO customers, the rate of depreciation determines the rate at which the $10m investment is recovered by the TSP. The rate of depreciation therefore determines the *rate of return of capital*.

86. The Commission must determine:

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

[11] Section 84(1)(b).

Determining the depreciation methodology

87. In determining the depreciation methodology and the depreciation parameters (such as asset lives), the primary concern of the Commission is to select a methodology which enables the TSP to recover the cost of prudent investment in providing the TSO, but no more than that amount.

88. The TSP's investments in infrastructure to provide the TSO are mostly long-lived and irreversible. In order to allow the TSP to recover the cost of prudent investment, the TSP must have the expectation of recovering the costs of such investment over the period in which the assets can be usefully used to generate revenues. This requires that the present value of expected revenues achieved from the infrastructure (net of operating and other non-capital costs) must be sufficient for the TSP to recover the up-front cost of the investment.

89. The Commission has adopted a tilted annuity depreciation methodology. Under the tilted annuity approach, the capital costs are adjusted over time in line with the rate of increase or decrease of the Optimised Replacement Cost ("ORC") of the capital equipment. If the replacement cost of the asset were declining over time, the capital costs would be higher early in the life of the asset and decline at the rate of decline of the replacement cost. The opposite would be the case if the replacement cost of the asset were rising over time.

90. The use of a tilted annuity also smoothes any 'jumps' that might occur when depreciation of a new asset commences at the end of the life of a previous asset.

Determining the parameters of a tilted annuity

91. In its first TSO determination, the Commission examined the parameters of a tilted annuity, to determine:

    a. The lives of the capital equipment; and

    b. The rate of change of the replacement cost of the capital equipment.

<u>Lives of capital equipment</u>

92. 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 in determining how much the asset life should be shortened to avoid any expected stranding of assets that would otherwise occur as a result of technological change or changes in demand.

93. The Commission has used information provided by Telecom and TelstraClear to assess the most reasonable values for asset lives.

<u>Rate of change of the replacement cost of capital equipment</u>

94. Two sources of evidence inform estimates of tilt: changes in the price of capital equipment in the recent past; and industry expectations of the likely changes in these prices.[12] TelstraClear and Telecom provided information on the level of the tilt to be included. The Commission has adopted the evidence provided by Telecom for the tilt factors.

Use of tilted annuities in the TSO

95. This section provides an overview of the use of tilted annuities as a means of calculating the annual capital cost of the TSO.

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[12] Commerce Commission, *TSO Implementation Issues Discussion Paper and Practice Note*, 19 April 2002, p56

96. An important component in determining the unavoidable net incremental costs of the TSO are costs associated with the employment of capital. These capital costs include an appropriate return on capital employed (reflecting the opportunity cost of that capital), and a return of capital over time (depreciation).

97. In assessing the unavoidable net incremental cost of the TSO, the Commission has used a tilted annuity. An annuity is a mechanism for generating a series or profile of annual capital payments which combine a *return on capital* and a *return of capital* over time. The annuity can be tilted in order to allow recovery of invested capital in the face of changing real asset prices. For example, where asset prices are declining, the annuity profile can be "front-loaded" such that a higher proportion of capital is recovered earlier in the life of the asset.

98. Under a tilted annuity, the annual capital cost is given by:[13]

Equation 1: Annualised Capital Costs

$$V \cdot \frac{(1+\alpha)^{t-1} \cdot (r-\alpha)}{1-\left(\frac{1+\alpha}{1+r}\right)^{N}}$$

where
V = the optimised replacement cost (ORC) of the asset
α = the nominal rate of change of the ORC of the asset
N = the economic life of the asset
r = the rate of return on capital
t = a particular year in the life of the asset

99. A tilted annuity adjusts the capital costs over time in line with the nominal rate of change in the ORC of the asset. An example of the stream of capital costs generated by a tilted annuity is given in Table 2 below, where it is assumed that the rate of change in asset prices (α) is -5% p.a., the weighted average cost of capital (r) is 6.4%, the asset life is 10 years, and the initial capital investment is $100.

Table 2: Tilted Annuity

year	ORC (1)	Total Capital Cost (2)	Depreciated capital (3)	Return on Capital (4)	Return of Capital (5)
1	$100.00	$16.81		$6.40	$10.41
2	$95.00	$15.97	$89.59	$5.73	$10.24
3	$90.25	$15.17	$79.35	$5.08	$10.10
4	$85.74	$14.42	$69.25	$4.43	$9.98
5	$81.45	$13.69	$59.27	$3.79	$9.90
6	$77.38	$13.01	$49.37	$3.16	$9.85
7	$73.51	$12.36	$39.52	$2.53	$9.83
8	$69.83	$11.74	$29.69	$1.90	$9.84
9	$66.34	$11.15	$19.84	$1.27	$9.88
10	$63.02	$10.60	$9.96	$0.64	$9.96
NPV		$100.0			

100. In the context of the TSO, the initial $100 investment represents the capital employed in an efficient network designed to supply the TSO services. For example, in terms of the Commission's modelling of an efficient service provider, this would be the capital

[13] The tilted annuity used in the TSO model includes an additional term which reflects a "time to build" factor.

base associated with the scorched node network, with modern equivalent assets installed. The ORC is allowed to decline at the assumed rate of -5% p.a., as shown in column (1) of Table 2.

101. The total capital cost (column (2)) each year is calculated using the tilted annuity formula. The net present value of this stream of annual capital costs equals the initial investment. In other words, the TSP is expected to fully recover the costs of its initial investment in supplying the TSO services.

102. The total capital cost given in Table 2 can be broken down into the return on capital (column (4)) and the return of capital (column (5)).

103. In summary, the above simple example considers an efficient initial investment of $100 in supplying TSO services, and shows the annual capital costs that need to be funded in order for the TSP to be able to recover its initial investment.

Optimization and Use of Tilted Annuities in the TSO Context

104. The original TSO model has been developed in a number of ways, including the introduction of a modified radio cap. The cap can result in different technologies being swapped in to and out of the model.

105. The operation of the radio cap can be simply characterised as follows. The initial TSO investment (*V*) is based on fixed technology. The TSO model designs an efficient network by taking certain network nodes and ‘scorching’[14] the existing access network given the location of those nodes. This produces an initial asset base of $100.[15]

106. Where it is cost effective to do so the TSO model effectively replaces the fixed line network technology with radio-based technology.[16] The model’s mechanism for selecting the lowest cost technology is based on a comparison of the respective NPVs of the two technologies extended ad infinitum, then selecting the lesser of the two NPVs. The annualised capital cost reported from the tilted annuity is used in calculating the capital related yearly cost.

107. By testing the technology mix each year, the TSO model is in effect undertaking a degree of annual re-optimisation. This leads to a situation where some of the assets used to deliver the TSO services may be stranded as a result of the introduction of new technology.

108. Given the Commission’s scorched node model it is likely that the technology mix will be relatively stable in the medium term.

Competing Technology (Radio Cap) Optimisation Decision Rule

109. In the final TSO determination for 2003/2004 the Radio Cap was characterised by a fixed cost per line. The TSO program tests each non viable cluster. Those with a per line cost that is greater than the radio cap threshold are capped i.e. costed as having service provided by the cap technology. An annualised cost was used for both the threshold test and the cost per customer.

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[14] Scorching is described at paragraph 57

[15] If instead the costs of the TSP’s actual embedded network were modelled, this might have resulted in the initial V being, say, $150. Therefore, the concept of an ‘efficient service provider’ (as per the Act’s definition of the net cost of the TSO) results in an efficiency adjustment of $50 in the initial modelling.

[16] Again this is a simplification. In reality, the radio cap only leads to new radio based technologies (MAR, WLL, GSM) being introduced in certain areas (rather than wholesale replacement of the entire network).

110. NERA submitted that the decision rule behind the TSO optimisation may be able to be improved. Specifically , NERA submitted that in selecting the lowest cost technology, the model should not compare annualised costs, but should instead compare the present value of future costs.

111. In the 2003/2004 final determination , the Commission concluded that "the NERA proposal for identifying the lowest cost technology in the TSO model may represent a more robust approach in principle and is worthy of further study".[17]

112. The Commission has given further consideration to NERA's proposal to identify the least cost technologies for the TSO period. The changes are detailed in 'Appendix 1: TSO Model Inputs, Updates and Changes'. The Commission's view is that the change identified by NERA provided a more robust principled approach to the calculation of the TSO cost.

[17] Commerce Commission, *Final Determination for TSO Instrument for Local Residential Service for period between 1 July 2003 and 30 June 2004*, 27 March 2007, para 228

TSO COST OF CAPITAL

Introduction

113. Section 84(1)(b) of the Act requires that the calculation of the TSO net cost allow the TSP a reasonable return on the incremental capital employed in providing the TSO services to CNVCs. The reasonable return is the opportunity cost of the funds invested in the network and non-network assets by an efficient service provider. It is the rate of return an investor would expect to achieve by investing in assets with a similar risk profile. If the TSP is not able to earn its cost of capital, its incentives to invest in TSO assets will be undermined.

114. In its previous determinations of the net cost of the TSO, the Commission set out its detailed views on the cost of capital in relation to the TSO. In terms of the current determination of the net cost of the TSO, this section builds upon the position taken in the Commission's previous TSO determinations, and reviews the various components of the cost of capital. Where appropriate, estimates are updated to reflect the different period under consideration and any relevant information that has emerged since the previous determination.

Overview of the Approach

115. Firms are typically funded by a combination of debt and equity. A firm's cost of capital therefore represents the weighted average cost of equity and debt, with the latter net of the corporate tax deduction. The weighted average cost of capital, WACC, is calculated using the following equation:

$$WACC = k_e(1-L) + k_d(1-T_c)L \qquad (1)$$

where: k_e is the cost of equity capital,
k_d is the cost of debt,
T_c is the corporate tax rate
L is the financial leverage ratio (i.e. debt to total capital).

116. Consistent with its approach in the previous TSO determinations and in other regulatory contexts, the Commission has again adopted this equation to estimate the appropriate WACC for the TSO for the 2005/2006 period.

Cost of Debt

117. The cost of debt, k_d, measures the cost to the firm of borrowing funds. It represents the interest rate required by investors to hold the firm's debt, given the risks they bear. It can in some cases be observed directly as the yield on debt issued by a company (e.g., a bond issue with a specified return), or the cost of banks' lending to borrowers. However, typically it is estimated as the sum of the risk-free rate (R_f) and a premium (p) to reflect marketability and risk of default. Thus, the cost of debt is defined as:

$$k_d = R_f + p \qquad (2)$$

Cost of Equity

118. The cost of equity is the rate of return required by investors on equity that compensates them for the risk they bear. It represents the opportunity cost of the funds they have invested. In accordance with previous TSO determinations and its current practice in respect of its other regulatory functions, the Commission has used

the simplified version of the Brennan-Lally capital asset pricing model, CAPM. The simplified Brennan-Lally CAPM is expressed as follows:

$$k_e = R_f(1 - T_I) + \beta_e MRP \quad (3)$$

where: β_e = equity beta

MRP = market risk premium

T_I = is the average (across equity investors) of their marginal tax rates on ordinary income

119. The definition of the MRP consistent with the simplified Brennan-Lally model is given by the following equation:

$$MRP = k_m - R_f(1 - T_I) \quad (4)$$

where: k_m = expected rate of return on the market portfolio

120. The Commission uses the simplified Brennan-Lally CAPM to estimate the TSO cost of capital for the TSO period.

Estimation of the Model Parameters

Risk Free Rate

121. The risk-free rate is used in calculating both the cost of debt and the cost of equity. The risk-free rate is the interest rate that an investor would require to invest in a risk less asset. The risk-free rate is proxied by the yield to maturity on government bonds.

122. The major issue in determining the risk-free rate is which maturity of government bonds to use. The other issue is the period of averaging of observed returns.

<u>Appropriate maturity</u>

123. The CAPM is a single period model which provides no guidance as to the appropriate maturity of government bonds to use for the risk-free rate.

124. In accordance with its past decisions on the cost of capital, the Commission uses a risk-free rate of a maturity matching the regulatory period. In the case of the TSO, the regulatory period is one year.

125. The one-month arithmetic average of the annualised 12-month government stock rate prior to 1 July 2005 results in a risk-free rate of 6.4%.

Market Risk Premium

126. The MRP measures the additional expected return over and above the risk-free rate required to compensate investors for holding the market portfolio. It therefore represents the premium investors can expect to earn for bearing only systematic (common) risk. As such, the MRP is not a firm-specific parameter, but rather, is common to all assets in the economy.

127. The various approaches that can be used to estimate the MRP can be classified into two broad categories: ex post or historical methods; and ex ante methods. There is continuing debate over the appropriate methodology to use to estimate the MRP, and its size. All the different methodologies have advantages and disadvantages, but they all help to inform the estimation of the MRP. The Commission therefore estimates the MRP based on estimates produced by both ex post and ex ante approaches, rather than preferring some approaches over others.

128. The TSO final determination for 2002/2003 discussed the issue of the MRP, and in particular, the question of consistency of risk-free interest rate terms within the CAPM. The Commission concluded that, on balance, an assumption that the MRP is invariant across different time horizons is reasonable and practicable.

129. The Commission considers that the appropriate point estimate of the MRP for the TSO period is 5.5% to 8.5% range,[18] and uses a point estimate of 7% for this determination.

Beta

130. Beta measures the sensitivity of an investment's return to the market return. Risk relates to the possibility that returns may deviate from expected returns. The total risk of an asset or business is made up of both systematic and unsystematic risk.

131. Unsystematic risk is specific to the asset or firm, and may be eliminated by diversification. The risks associated with technology obsolescence, increasing competition, patent approval, antitrust legislation, management styles and geographic location are all examples of diversifiable risks.

132. Systematic risk is market risk, which is not unique to the firm. Such risk cannot be eliminated by diversification. It is related to, and dependent on, the state of the economy as a whole. The sources of systematic risk include changes in real GDP, inflation, currency movements and the long-term real interest rate.

133. As systematic risk is common to all firms, this implies that when the stock market falls (e.g., because of an increase in the world price of oil), all stocks are systematically affected by the same risk, although some to a greater or lesser extent. The beta seeks to capture the exposure of a particular asset to systematic risk by measuring the sensitivity of the asset's returns to market returns.

134. Only systematic risk is relevant in determining a firm's cost of equity within the CAPM framework. Investors are not compensated through the CAPM for diversifiable risk, since the assumptions of the model imply that investors hold a combination of the market portfolio of risky assets and a risk less asset, and this eliminates diversifiable risk.

135. Equity betas take into account the entity's leverage.[19] Financial risk is the incremental risk (the difference between the equity and asset betas) that arises when a firm takes on debt. Other things being equal, an increase in financial leverage will lead to an increase in the equity beta since a higher level of leverage implies a higher volatility of returns to shareholders. In other words, because obligated payments on debt do not vary with the level of revenues, and debt holders have a priority call on cash flows, financial leverage magnifies the systematic risk of the cash flows distributable to equity holders. The asset beta (β_a) measures the sensitivity of a firm's returns relative to market returns when the firm has no debt.

136. The relationship between equity beta and asset beta is given by the following formula:[20]

[18] Commerce Commission, *Draft Guidelines, The Commerce Commission's Approach to Estimating the Cost of Capital*, November 2005.

[19] *Weighted Average Cost of Capital for Christchurch International Airport*, Crighton Seed and Associates, June 1999, p 8.

[20] The first formula of this type was developed by Hamada (1972). The specification of the relationship between equity and asset beta shown above assumes that debt is tax neutral and that debt has a zero beta.

$$\beta_e = \beta_a \left[1 + \frac{L}{1-L} \right] \qquad (5)$$

where β_a is the asset beta, i.e., the equity beta in the absence of debt.

137. If a firm has no debt (i.e., it is entirely financed by equity and hence $L = 0$) then its asset and equity betas are identical. For otherwise identical investments, a company with more debt in its capital structure will have a higher equity beta and a higher required rate of return on equity than a company with less debt.

138. Information from a range of sources may assist in determining the appropriate beta for investments in the provision of the TSO. They are:

- consideration of the factors influencing betas;
- direct estimation of a firm's equity beta from market data; and
- estimates of equity betas of comparable firms in New Zealand or other countries (including TSO/USO providers in other countries).

139. Given the difficulties in estimating asset betas, these various approaches are not considered to be mutually exclusive alternatives, in the sense that any one should be relied upon in isolation from the others. The Commission believes that they should be considered in tandem. Each of these approaches has advantages and disadvantages, and can best be thought of as determining a range within which the beta lies.

<u>Beta estimate for TSO 2005/2006</u>

140. In its previous TSO determinations, the Commission has considered extensive analysis and estimation of an appropriate beta for the TSO. This analysis is based on information from a large number of sources, encompassing direct estimates of Telecom's beta, use of domestic and overseas comparators, and the assessment of influences and risks relating to the provision of TSO services. In its TSO final determination for 2002/2003, the Commission summarised the approach that it had taken with respect to the estimation of an appropriate beta for the TSO:[21]

> ... the Commission has considered the estimation of the TSO asset beta by decomposing an estimate of Telecom's PSTN beta into its constituent components. The Commission believes that this alternative approach to beta estimation for the purposes of the TSO represents a useful cross-check on the approach taken for the 2001/2002 TSO determination. This reflects the Commission's view, expressed earlier, that various approaches can be taken to estimating asset betas, and that there is value in considering these approaches together, rather than relying on any one methodology.

141. The Commission concluded by noting that:[22]

> For the 2001/2002 TSO Determination, the Commission used an asset beta for the TSO of 0.40. For this determination, the Commission has used an alternative approach to deriving a TSO asset beta. The Commission considers that both of these approaches produce a range of beta estimates which are generally consistent.

142. Based on the consistency of the asset betas derived by the different approaches used in the previous TSO determinations, the Commission continues to consider an asset beta of 0.40 to be appropriate for the purposes of determining the net cost of the TSO for the TSO period.

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[21] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for period between 1 July 2002 and 30 June 2003*, 24 March 2005, paragraph 171.
[22] Ibid, paragraph 198.

Leverage

143. Leverage represents the level of gearing or the ratio of debt to total capital, i.e. debt plus equity. Under the simplified Brennan-Lally CAPM, the WACC is not materially affected by small changes to the leverage ratio.

144. In previous TSO determinations, the Commission concluded that an optimal leverage ratio should be used, and is best based on observations of the average leverage amongst relevant firms. Taking account of evidence of Telecom's current and past gearing, gearing of other telecommunication firms and the gearing for regulated telecommunication firms, the Commission adopted a leverage ratio of 30%.

145. A leverage ratio of 30% has been used for this determination.

Debt premium

146. The cost of debt is the promised yield on debt, i.e. the interest rate required by investors to lend funds to or to hold bonds of the firm.[23] The debt premium reflects the marketability of corporate bonds and the risk of default. Investors providing debt to firms are exposed to greater risk of default than when they hold government bonds. If the TSP's debt level and leverage increase, then the debt premium might also be expected to increase.

147. In the previous TSO determinations, the Commission considered the risk of the TSO business to be lower than that of Telecom as a whole. This is reflected in a lower asset beta for the TSO business, and may lead to a lower debt premium. For the TSP, the Commission concluded that a debt premium (including facilities fees and debt issuance costs) of 1.5% was reasonable.

148. A debt premium of 1.5% has been used for this determination.

Tax Rates

149. There are two tax rates used in the WACC model: the investor tax rate in the simplified version of the Brennan-Lally model, and the corporate tax rate in the cost of debt.

150. The investor tax rate is the marginal ordinary tax rate on investor income, which may include interest, dividends and capital gains. Under the simplified version of the Brennan-Lally model, it is assumed that capital gains taxes are zero, firms attach maximum imputation credits to their dividends, and shareholders can fully utilise their credits.

151. In the previous TSO determinations, the Commission has used an investor tax rate of 33%, consistent with the simple Brennan-Lally model.

152. For the reasons set out in previous TSO determinations, the Commission considers that an investor tax rate of 33% remains appropriate. Using a version of the Brennan-Lally CAPM model which allows for varying treatment of imputation credits does not appear to have a material impact on WACC.[24]

153. The corporate tax rate of 33% is the tax rate of the TSO business.

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[23] Strictly speaking, in the context of valuation where only expected returns are relevant, the cost of debt should be defined as the expected yield on debt. However, in most cases, the difference between the expected and promised yield on debt is slight and unlikely to be significant. Furthermore, the promised yield or contractual yield is easily observed, whereas the use of the expected yield would involve significant difficulties.

[24] See 2001-02 TSO determination, paragraphs 295-299.

154. For the purposes of this determination, the Commission has used a corporate tax rate of 33%.

Overall TSO WACC for 2005/2006

155. In reviewing the TSO WACC for the TSO period, the Commission has considered which of the parameters used in the previous TSO determinations need to be re-estimated. The risk-free rate for the TSO period is 6.4%.

156. Other WACC parameters are unchanged from the 2003/2004 TSO determination.

157. Table 3 sets out the parameters of the cost of capital of the TSP business for the TSO period.

Table 3: TSO Cost of Capital Parameters for 2005/2006

	Low	**High**	**Commission's Point Estimate**	**Telecom**[25]
Risk Free Rate	6.4%	6.4%	6.4%	5.8%
Market Risk Premium	5.5%	8.5%	7.0%	7.5%
Equity Beta	0.429	0.714	0.571	1.14
Asset Beta	0.30	0.50	0.40	0.80
Cost of Equity	6.66%	10.37%	8.30%	12.7%
Debt Premium	1.2%	1.8%	1.5%	1.6%
Cost of Debt (pre-tax)	7.62%	8.22%	7.92%	7.40%
Gearing	30%	30%	30%	30%
Corporate Tax Rate	33%	33%	33%	33%
Investor Tax Rate	33%	33%	33%	28%
Post-Tax Nominal Cost of Capital or WACC	**6.19%**	**8.91%**	**7.40%**	**10.4%**

158. The post-tax nominal cost of capital (WACC) for the TSO period is in the range of 6.19% to 8.91%, with a point estimate of 7.40%.

159. The post-tax WACC for this determination is 7.4%.

[25] Telecom's TSO cost calculation for 2005/2006 does not include a specific cost of capital estimate. The figures included in the above table under "Telecom" are based on the PWC submission on behalf of Telecom for 2003/2004 (PWC, 17 September 2004). The one exception is the risk-free rate, which according to Telecom should be based on long-run government bond rates. The PWC submission referred to estimates of the average ten-year government bond rate applicable to the period 2003/2004. The Commission has estimated the corresponding average applicable to 2005/2006 to be 5.8%.

TELECOM'S COST MODELLING

160. For the 2001/2002 TSO period, Telecom used its own cost model to calculate the TSO net cost. The Commission analysed this model and concluded that it had various disadvantages that limited its utility in calculating TSO net costs and, therefore, that the results from Telecom's model were not suitable for use by the Commission in determining the TSO net cost.[26]

161. Accordingly, the Commission undertook its own cost modelling exercise using the CostProNZ and HCPM cost models to determine the TSO net cost.

Requirements for 2005/2006

162. The Commission instructed Telecom to use the Commission's cost models and input data to calculate the TSO net cost for the TSO period.

163. Telecom was instructed to:

    a) use the Commission's CostProNZ and HCPM models as they were used for the Commission's draft TSO determination for 2003/2004;

    b) use the input data for CostProNZ and HCPM models that was used in the Commission's draft TSO determination for 2003/2004, but:

        i. update revenue and traffic information to 2005/2006;

        ii. use a WACC of 10.5% for Telecom Mobile;

        iii. use a WACC of 14% for Xtra; and otherwise

        iv. use a WACC of 6.4% .

164. Telecom has complied with the above instructions but argues that:

    a) section 83 does not allow the Commission to provide binding directions on the cost of capital. Binding section 83 Commission requirements are limited to section 84(2) matters; and

    b) the cost of capital of 6.4% is considered unreasonable and is not appropriate for the TSO period.

Telecom's TSO Net Cost Calculation

165. As required by the Act Telecom provided the Commission with its calculation of the net cost of complying with the TSO for the TSO period. That calculation was made using the Commission's models, and assumptions specified by the Commission, resulting in a TSO cost of $45.7 million, excluding an adjustment for the Chatham Islands.

166. Since that calculation was made, the Commission has issued the 2003/2004 determination. That determination incorporated changes to the costing model used by Telecom. Those changes along with an increase to the WACC for the TSO period have led to the result that the Telecom calculation is lower than the Commission's calculation in this draft determination.

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[26] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for period between 20 December 2001 and 30 June 2002*, December 2003, pp 83-97

COMMISSION'S COST MODELLING

Modelling Issues

167. The cost of the TSO arises from the possibility that revenues from some residential telephone customers do not cover the economic costs of providing the TSO services. Such customers may be, for example, groups of remote rural customers who are served using expensive infrastructure.

168. To determine the net cost, it is necessary to identify commercially non-viable customers or groups of customers and to calculate the incremental costs to an efficient service provider of serving these individuals/areas. This requires modelling of the efficient costs and revenues of customers and groups of customers in New Zealand. Some of the principles to be followed in modelling costs and revenues for the TSO net cost calculation were discussed in "Identifying the net cost of the TSO" on page 20.

169. Following on from these principles are a number of issues that need to be considered when building a model of a telephone network to estimate the cost of serving residential customers. Some of these issues are generic issues common to most kinds of network modelling and others are more specific to the modelling required to calculate the TSO net cost.

170. The model design should support the delivery of the TSO services to all CNVCs in conformity with the service standards in the TSO Deed. Where design decisions are required on elements of those standards beyond matters expressly dealt with in the TSO Deed, the Commission will have regard to the service outcomes experienced by most customers.

Top-down vs. Bottom-up

171. Networks are generally modelled on a top-down or a bottom-up basis. A top-down model typically starts with engineering data and accounting information from a real network and makes various adjustments to the inputs with the intention of estimating the costs to an efficient network operator of providing the relevant service. A bottom-up model, on the other hand, builds a theoretical model of a forward-looking efficient network from the ground up, and uses this to calculate costs.

172. A bottom-up modelling approach (rather than a top-down modelling approach) is most likely to provide a reliable estimate of the net cost of the TSO, and is most consistent with the requirements of the Act. Bottom-up modelling:

- more directly estimates the costs of an efficient service provider in delivering the services required under the TSO deed;
- is likely to be better at identifying and estimating the unavoidable incremental costs of providing the services to groups of customers within a particular area;
- allows for a more transparent modelling process; and
- provides the Commission with more control over the modelling process.[27]

Degree of Optimisation

173. The degree of optimisation refers to how efficient the modelled network design is compared to technology and architecture currently existing in the network. The

[27] Commerce Commission, *TSO Position Paper*, 30 September 2002, Section 3.1

efficiency of a network depends on the routing of the traffic, the number of exchanges and the type of equipment used. A fully optimised network would probably use a completely new network topology with the most efficient routing, optimal number of exchanges and the latest technology to connect all customers.

174. When a network design is not bound by the location of existing exchanges, the approach is known as scorched earth. However, the modelling approach generally adopted by regulators assumes that the locations of at least some existing exchanges remain and the network is redesigned around them. This is known as the 'scorched node' approach.

175. The Commission considers that some degree of optimization in its cost modelling is necessary to maintain strong incentives for the TSP to invest efficiently, while also acknowledging that the evolution of an efficient network depends on past decisions. Therefore the Commission has adopted a scorched node approach, optimising the network architecture around existing nodes, considering the range of best-in-use technologies. 'Nodes' are the points in Telecom's network where a switch or a RLU was located at 20 December 2001.

176. The Commission has used a model designed so that:

- equipment in the network between the network termination point (customer's premises) and the first node in Telecom's current network may be optimised, including equipment, technology and layout;
- equipment at nodes can be optimised (e.g. replace a switch with an RLU); and
- some nodes with a small number of lines can be removed.

177. The model largely retains Telecom's network design beyond the nodes, back into the core network. Any optimisation proposed by the parties must be consistent with these assumptions.

Trade-off between Operational Costs and Capital Costs

178. The design of a telephony network and the age and type of equipment in the network affect its operational costs. Cheaper equipment often has higher maintenance costs, so savings in capital costs by using such equipment may be offset by these higher operational costs. Older networks (with a lower value) also tend to have higher operational costs than newer, higher value networks.

179. A network cost model may, therefore, overstate overall costs by combining capital costs using the price of new, good quality equipment and operational costs, such as maintenance, using actual network expenditures from a network with a significant amount of older, lower quality equipment.

180. The Commission has estimated operational costs using actual reported operational costs from Telecom and has not attempted to make any allowance for the fact that Telecom's equipment is older than equipment assumed to be used in the modelled network.

Impact of Business Customers

181. Telecom serves business customers in higher cost, rural areas at standard prices even though it is not obliged to do so under the TSO. When modelled, the cost of serving some of these business customers may be higher than the revenue received.

182. For TSO cost modelling, it would not be fair to attribute the various costs of serving unprofitable business customers to the cost of serving residential customers.

However, since business and residential customers share the same network, many costs will inevitably be shared between business and residential customers. Such shared costs are difficult to separate.

183. If the TSO did not exist, it is likely that Telecom would continue to serve its business customers. The prices charged to these businesses may rise to make servicing them economic but this is unlikely to cause those customers to disconnect because the demand from businesses for basic telephone services is generally considered to be highly inelastic. Ideally this means that the TSO cost modelling should recognise the infrastructure put in place (or that an efficient provider would put in place) to serve business customers, and only the incremental cost imposed by adding residential users to this infrastructure should be counted in the net TSO cost. Alternatively, an economic cost allocation scheme would allocate most of the common cost to the inelastic business demand. However, such a modelling approach would be complicated to implement.

184. Trenching is the main cost in the access network and trenches are shared between lines going to businesses and lines going to residential customers. Arguably, the trenching costs used in the TSO net cost calculation should be reduced to take account of such sharing, as suggested above. Otherwise, the cost of business customers is treated as incremental to residential customers, which effectively amounts to residential customers subsidising business customers. The Commission notes that Telecom's consultants recognise that the TSO effectively makes it cheaper to serve business customers because they state that:

> Both TSO and non-TSO customers benefit from the availability of universal access resulting from the TSO deed requirement on Telecom to provide nationwide service for residential users.[28]

185. The Commission has taken a conservative approach to modelling the impact of business customers. To prevent the costs of unprofitable business customers from contributing to the TSO net cost at a cluster level, the model tests whether the average cost of any business lines in each commercially non-viable cluster exceeds the average income per line within the cluster. If average business costs exceed revenues, both the revenues and costs attributable to business lines are removed from the calculation of cluster net cost.

Model Implementation

186. The Commission is aware that network cost modelling exercises are generally resource-intensive and costly. In balancing this consideration against the benefits of a bottom-up model to the Commission's process, the Commission proceeded with a two-stage model implementation:

1. CostPro New Zealand (CostProNZ) purpose built model for design and costing of switching and transport components; and
2. Hybrid Cost Proxy Model (HCPM) public domain model for optimisation and costing of access network components.

187. The Commission considers that this approach provides a sophisticated model with significant cost benefits, transparency of process and flexibility for upgrade and re-use of model components.

[28] Commerce Commission, *TSO Position Paper*, 30 September 2002, Section 3.1.

Specific Modelling Approach

188. The specific modelling approach adopted for the TSO period has been driven by, and is consistent with, the Commission's positions on the key modelling options above. This approach involves the choice of architectures and technologies consistent with likely investment decisions of an efficient operator during the TSO period.

Switching and Transport

189. The switching network model is based on conventional PSTN technology configured into a four-tiered architecture of nodes as follows:

- remote multiplexer/transmission sites providing MDF, line card and transport services across feeder links to local exchanges;
- RLUs which provide MDF, line card and traffic concentration services and are hosted by local exchanges;
- Local Exchanges (LX) providing MDF, line card, traffic concentration, RLU hosting, local switching and CCS #7 signalling; and
- Tandem and Gateway switches, which provide inter-region and international switching of traffic.

190. In addition, the architecture includes special purpose and service specific nodes including Intelligent Network (IN) and Signalling Transfer Points (STPs).

191. The Commission considers that conventional PSTN switching constitutes the best 'in-use technology' choice consistent with the Commission's modelling approach and the timing of this determination. Voice over IP (VoIP) options were considered but rejected at this time due to the fact that:

- during the TSO period VoIP was a developing technology in carrier scale public networks; and
- commercially viable VoIP implementation of TSO type services is likely to be part of a larger broadband service rollout or a network upgrade programme, which is dependent on projected revenues from innovative non-TSO services.

192. The switching architecture adopted for this determination has been designed to allow for replacement or removal of key nodes as carrier grade VoIP reaches large scale adoption. For example, RLU functionality can be replaced with VoIP Gateway in a manner consistent with practical network upgrades and without affecting the scorched node methodology.

193. The transport network architecture is based on Synchronous Digital Hierarchy (SDH) fibre optic rings providing the linking and route diversity between switching network nodes. Some smaller nodes or remote multiplexer/transmission systems are linked to rings by individual 'spur' fibre cables that lack route diversity. Some linking to remote and offshore sites is provided using Digital Microwave Radio (DMR) systems. Access, Distribution and Feeder Radio Technology Cost Cap.

194. The modelling of the wire-line access network is based on a three-tier architecture consisting of:

- drop cables (copper), which link the customer premises to a Drop Terminal/Cable Terminal (CT). This is normally a short cable run from house to road;

- distribution cables (copper), which link the CT to either the node MDF or to a Feeder Cabinet; and
- feeder cables (fibre and copper), which link the Feeder Cabinet to the node.

Radio Caps

195. The Commission considers that, although the scorched node modelling approach permits full optimisation of the network between the customer and node, the wire-line copper pair generally remains the most efficient and best in-use technology platform for TSO service delivery for the current TSO period.

196. However, in its 2001/2002 TSO[29] Determination, the Commission implemented a 'Radio Technology Cost Cap' within the model, which identified TSO areas where a multi-access radio (MAR) fixed radio solution would be more efficient, i.e. where modelled wire-line costs exceed the cost of a MAR solution which serves as a cost cap. The Commission has again adopted such a cost cap for this determination and these areas are re-modelled using MAR radio system costs for the purpose of calculating any associated TSO net cost.

197. The Commission in its 2002/2003 determination started using Wireless Local Loop ("WLL") as a second TSO fixed radio solution. The wireless local loop modelling is based on the cost and performance of Airspan series 4000 radio systems and customer premises equipment. This is technology currently deployed by Kordia for radio DSL in some Project Probe regions, and is one of the technologies identified by TelstraClear as appropriate for New Zealand.

198. A third radio cap was introduced for the 2003/2004 TSO Determination. This cap uses GSM technologies and is referred to as the MT or 'Mobile Technologies' cap.

199. Four radio cap solutions were examined for this determination. They are based on GSM[30], CDMA[31], WLL[32] and MAR[33].

200. The Commission has developed a weighted average radio customer cost per annum. The Commission has identified 201 ESAs with geography appropriate for WLL and has tagged these within the TSO model. A subset of 79 ESA's with similar geography has been identified as being suitable for both MT and WLL technology. The TSO model will select the most cost effective solution to deliver at least the requisite service quality levels. For all other ESA geographies, WLL costs are unpredictable, being highly dependent on customer locations, and the MAR radio cost cap remains in place.

201. The MAR cap NPV is valued for 2005/2006 at \$[ ] CCRI; the WLL cap at \$[ ]CCRI and the MT cap at \$[ ]CCRI. The MAR cap is lower than either of the other caps. The TSO optimisation process will apply this cap before the other caps are applied.

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[29] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for period between 20 December 2001 and 30 June 2002*, December 2003, para 459

[30] Model details are available under 'C:\hcpm\model_lib\GQ_radio_model'.

[31] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for period between 20 December 2001 and 30 June 2002*, December 2003, para 459

[32] ibid

[33] Model details are available under 'C:\hcpm\model_lib\mar_model'.:

TSO NET COST CALCULATION

Modelling Update

202. The Commission's TSO net cost calculation tool has been updated to version 7.01.01. This update incorporates the changes to input values and methodology described in 'Appendix 1: TSO Model Inputs, Updates and Changes' of this draft determination.

203. In summary, the key updates from the 2003/2004 final determination are:

   - choices between competing technologies are based on selecting the proposition with the lowest NPV;
   - WACC updated;
   - update of the tilted annuity formula to ('t = 5');
   - update of MAR, WLL and MT caps; and
   - update of revenue and traffic information.

204. The overall operation of the model is consistent with the previous versions.

Model Input Specifications

205. For the purposes of calculating the TSO net cost the Commission has used the following versions of models and inputs:

   - CostProNZ: Version v2.2d and 'HCPM0506v22' scenario; and
   - HCPM: 7.01.01 of the Commission's model and 'V7_0 hcpm_current_inputs.xls' providing the input values to many of the HCPM parameters.

206. In addition to the HCPM input spreadsheet, HCPM now integrates incremental per customer capacity costs by ESA and direct ESA costs generated by CostProNZ.

TSO Net Cost

207. The Commission's calculation for the TSO period is based on the annual net cost estimated by the Commission's TSO net cost model. This model calculates the TSO net cost inclusive of the cost for serving the Chatham Islands, for which complete modelling information is not available.

208. The Commission's TSO net cost model, operated according to the input specifications detailed above, at a post-tax WACC of 7.4%, and with 'Distribution Network' optimisation set to '500' calculates the following cost for the TSO period:

Table 4: TSO Net Cost Model Calculation: Annual Period Beginning 1 July for TSO 2005/2006

Annual TSO Net Cost	$ 78.3 M
Residential CNVCs	58,025

209. The commercially non-viable customers constitute 4.8% of the 1.210 million residential customer lines modelled.

Chatham Islands Adjustment

210. Cost modelling for the Chatham Islands is detailed in ‘Appendix 5: Chatham Island Adjustment’. This modelling identifies the following additional annual costs associated with providing TSO services to the islands:

Factor	Per Annum Cost
Additional Radio Lines	$[ ] CCRI
Earth Station & Space Segment	$[ ] CCRI
Total Adjustment	$762,896

211. This adjustment is provided as a user adjustable input to the Commission’s TSO model i.e. it does not have to be added to the models reported loss calculation.

Price Path Adjustments

212. A number of changes have been applied between the 2003/2004 Final Determination dated 23 March 2007 and this Draft Determination, including:

- MAR Radio Cap annuity from $[ ] CCRI to $[ ] CCRI;
- WLL Radio Cap annuity from $[ ] CCRI to $[ ] CCRI; and
- MT Radio Cap annuity from $[ ] CCRI to $[ ] CCRI.
- NPV for the MAR, WLL and MT caps has been calculated as $[ ] CCRI, $[ ] CCRI and $[ ] CCRI respectively.

213. These changes have been explored on Table 5 below. The ‘cost path’ could be traversed in a number of ways. The order that has been chosen was selected because it tested out the effect of global changes, then the more localised changes.

214. The factors have been progressively introduced into the loss calculation giving an idea of the contribution that each factor has to the overall TSO loss. The simulation period (t=’5’) takes the simulation into the TSO period. The successive entries are updates to parameters used in the draft 2004/2005 TSO Determination dated 9 July 2007. The effect of these updates is shown on both Table 5 and Figure 1 below.

Table 5: Cost Path Analysis of TSO Cost Including Chatham Adjustment

Incremental Change	TSO Cost Assessment $M
Draft Cost Calculation 2004/2005	71.4
Updated Traffic / parameters regressed to 2004/2005 (FTM was not regressed)	75.4
Period (t) updated	73.7
WACC updated	77.5
MAR updated	78.2
Chatham & WLL & MT updated	78.3
Draft 2005/2006	78.3

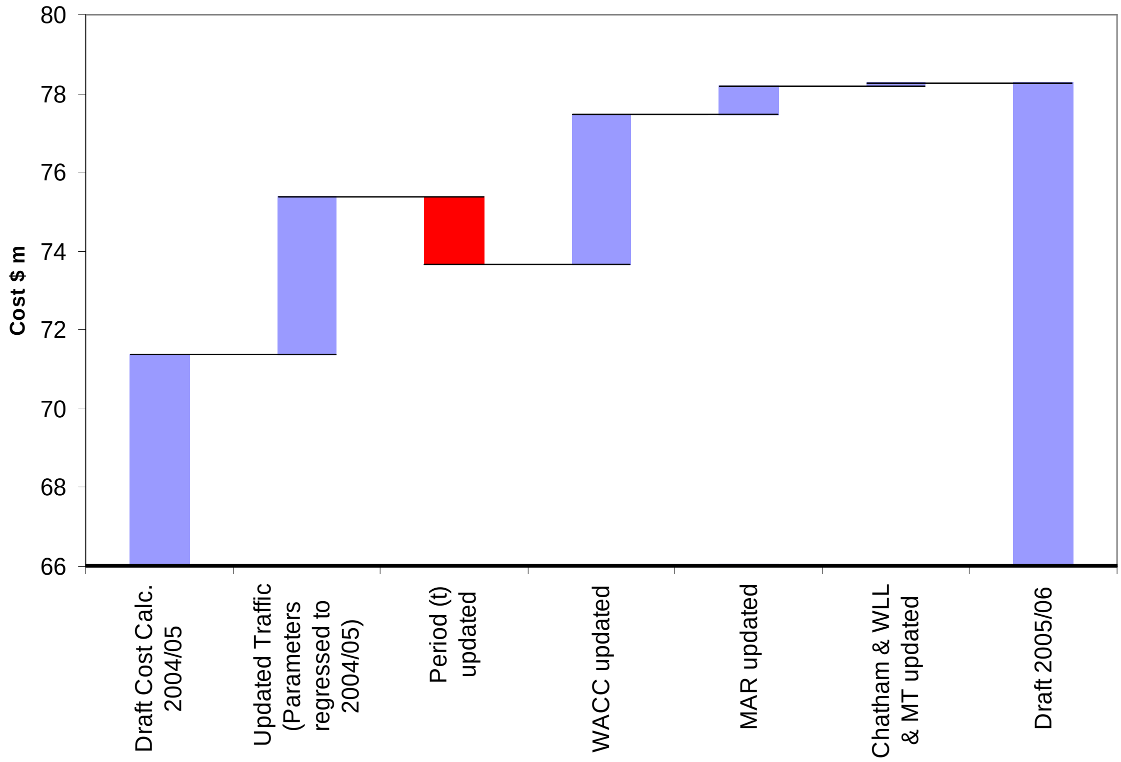

Figure 1: Effect of Progressive Implementation of updates on the TSO Cost

Overall Modelling Outcomes

215. The TSO Net Cost Calculation Tool produces a diagnostic file. This is the ‘national.csv’ file located in ‘c:\hcpm\tso\wk_lib’. The file has been analysed to produce contextual information.

216. The following information has been summarised from the file:

- Cluster CNV – this is a count of all the clusters that are CNV;
- Cluster – this is a count of all the clusters;
- Res Access Lines – this is a count of all the Residential Access Lines;
- Res CNVC Access Lines – this is a count of all the Residential CNVC Access Lines; and
- Total CNVC Cost – this is the TSO cost for this period exclusive of the Chatham Islands Cost.

217. The information that has been summarised from the 'national.csv' file has been analysed to produce three overarching metrics. They are:

- the percent of clusters that are CNV;
- the percent of residential access lines that are CNV; and
- the total CNV cost per Residential Access lines.

Table 6: Modelling Outcomes (NZ excl Chatham Is.)

	2004/2005 Draft Determination	2005/2006 Draft Determination
WACC	7.1%	7.4%
Cluster Total	3509	3509
Cluster CNV	1892	1965
% Clusters CNV	53.9%	56.0%
Res Access Lines	1,210,448	1,210,448
Res CNV Access Lines	53,215	58,025
% Res Access Lines CNV	4.4%	4.8%
Total CNV Cost	$71,409,963	$78,252,780
Total CNV Lines	53,215	58,025
Total CNV Cost/CNV Line	$1341.92	$1348.61

218. The WACC used in the 2004/2005 period is greater that that used in the previous year. This greater WACC has increased the overall economic cost of the supporting network.

TSO Technologies

219. The TSO Cost Calculation Tool models the use of four different types of technology for the TSO period. They are: Wired, Multi Access Radio, WLL, and Mobile Technology. The ESA cluster take up of this technology is shown on Table 7 below.

Table 7: Incidence of Technology used by the TSO Model (NZ excl Chatham Is.)

	Profitable				CNV			
Period (WACC)	Wired	Multi Access Radio	WLL	Mobile Technology	Wired	Multi Access Radio	WLL	Mobile Technology
2002/2003 (7.1%)	1430	0	45	na	529	1194	311	na
2003/2004 (6.4%)	1506	0	0	0	1103	900	0	0
2004/2005 (7.1%) draft	1615	2	0	0	1093	799	0	0
2005/2006 (7.4%) draft	1543	1	0	0	1161	804	0	0

Summary

220. The draft calculation for 2005/2006 has seen a general increase in the net cost of the TSO. This has been due to the net cost of the CNVC traffic and is also due to an increased WACC.

ALLOCATION OF TSO COST TO LIABLE PERSONS

221. The net TSO cost, once calculated, is allocated amongst liable persons.

The Definition of 'Liable Person'

222. Section 5 of the Act defines a 'liable person' in relation to a TSO instrument (except when they are the TSP). Telecom is a liable person and other persons are liable persons if they satisfy part (b) of the definition:

> (b) a person -
>
> (i) whose network is interconnected with a fixed PSTN operated by Telecom; and
> (ii) who provides a telecommunications service in New Zealand to end-users by means of some component of a PSTN that is operated by the person.

'A person whose network'

223. The definition of 'liable person' requires a network to be interconnected with a fixed PSTN operated by Telecom. A 'network' means a system comprising telecommunications links to permit telecommunication. It is not a requirement that a liable person must own the network it uses to supply services to end-users. It is sufficient that there is a network which is operated by a liable person and which is interconnected with a fixed PSTN operated by Telecom. The network operator will generally own or lease the network or otherwise have that network under its control.

'Is interconnected with a fixed PSTN operated by Telecom'

224. The term 'interconnection' has no agreed meaning within the telecommunications industry. The term will instead take its meaning from the context in which it is used.

225. TSO instruments are created in order to facilitate the supply of basic telecommunications services to groups of end-users within New Zealand to whom those services may not otherwise be supplied on a commercial basis or at a price that is regarded as affordable. The TSO instrument must define the service, identify the end-users to whom it is to be supplied, define the geographical area within which the service is to be supplied, specify the cost cap for the service, and any service criteria standards.

226. Given this context, the Commission believes that liable persons are required to contribute towards the net cost of providing TSO services because those persons benefit from the network externality arising from the fact that Telecom provides service to commercially non-viable customers at less than economic cost.

227. This suggests that the focus is on carriers with networks that are directly interconnected with Telecom's fixed PSTN and that therefore are able to exchange originating and terminating traffic with Telecom.

228. The Commission accordingly considers that networks are 'interconnected with a fixed PSTN operated by Telecom' when there is a direct linkage between the originating and terminating networks enabling the direct exchange of interconnect traffic with Telecom's fixed PSTN. Interconnect traffic is directly exchanged between carriers.

229. Customer-facing interfaces, such as ISP modem banks and PABXs, do not exchange originating and terminating traffic with Telecom in a manner that requires a formal

interconnection agreement with Telecom and therefore are not networks that are 'interconnected with Telecom's fixed PSTN'.

'Who provides a telecommunications services in New Zealand to end-users'

230. The Commission considers that a carrier whose network is interconnected with a fixed PSTN operated by Telecom qualifies as a liable person under the second limb of the definition by providing end-users with a retail telecommunications service or by providing a wholesale service on which the end-user retail service depends.

231. The extension limb of the definition of end-user ('… or of another service whose provision is dependent on that service') is meaningful only on the basis that the first service and the dependent service are supplied by different parties in a chain of supply. If the same person were the supplier of the dependent service and the retail service, the extension limb would be redundant.

232. The Commission has considered the scenario in which carrier Netco owns and operates a network which is directly interconnected with the Telecom PSTN, but has no retail customers, while carrier Servco acquires wholesale services from carrier Netco to provide its retail services. As Netco supplies a service used by Servco to supply its retail services, Netco's network is being used to provide telecommunications services to end-users and Netco is therefore a liable person. Netco is assessed for TSO purposes on its wholesale revenue received from Servco. In contrast, Servco is not a liable person because it is not interconnected with Telecom's fixed PSTN. The Commission may however in future determinations reconsider this conclusion in the light of the changes to section 79 under the 2006 Amendment Act.

'By means of some component of a PSTN that is operated by the person'

233. In Decisions 497 and 525, the Commission considered the meaning to be given to the words 'by means of'. The context in those Decisions was the interpretation of these words as they appear in part 2 of Schedule 1 of the Act within the description of retail services offered by Telecom to end-users 'by means of its fixed telecommunications network'. The Commission adopts the same interpretation for the purposes of the 'liable persons' definition. Accordingly, 'by means of' is to be understood as requiring a meaningful or not insignificant participation by some component of a PSTN operated by that person in the provision of the service.

234. A defining feature of a 'PSTN' is dial-up capability. Under the Act, a PSTN is 'a dial-up telephone network used, or intended for use, in whole or in part, by the public for the purposes of providing telecommunication between telephone devices'. The Commission therefore considers that a relevant component of a PSTN must provide dial-up capability.

235. Accordingly, the Commission concludes that a liable person for the purposes of this determination is any person, in addition to Telecom:

(a) Who owns or operates a telecommunications network that is directly interconnected (as defined above) with Telecom's fixed PSTN; and

(b) Who provides a telecommunications service in New Zealand either as a retail service to end-users or as a wholesale service to another carrier that is used by that carrier to provide another telecommunications service in New Zealand to end-users; and

(c) In either case referred to in (b) above, the telecommunications service is provided by means of some component of a PSTN providing dial-up capability and operated by that person**.**

236. The persons listed below were parties to interconnection agreements with Telecom during all or part of the TSO period. The networks of those persons were therefore directly interconnected with Telecom's fixed PSTN. The Commission is satisfied that each of these companies meets all of the conditions.

237. Those persons are:

- TelstraClear New Zealand Limited;
- Vodafone New Zealand Limited;
- Compass Communications Limited;
- CallPlus Limited;
- WorldxChange Communications Limited;
- TeamTalk Limited;
- ihug Limited; and
- Woosh.

Kordia

238. Although there is a physical connection between Kordia's[34] Extend network and Telecom's fixed PSTN, Kordia was not directly interconnected with Telecom's fixed PSTN during the TSO period nor did Kordia provide a PSTN service to end-users. Accordingly, Kordia is not a liable person for the purposes of this determination.

Vector Communications Limited (Vector)

239. Vector owned a telecommunications network during the TSO period. However, that network was not directly interconnected with Telecom's fixed PSTN. Accordingly, Vector is not a liable person.

Woosh Wireless Limited (Woosh)

240. Woosh owns a telecommunications network and was directly interconnected with Telecom's fixed PSTN during the TSO period. Woosh was using its interconnection to Telecom to directly or indirectly provide a telecommunications service to end-users during the TSO period. Woosh is therefore a liable person for the purposes of this determination.

Internet Service Providers

241. Some network operators provide ISP services in conjunction with voice telephony services. Others however do not provide voice services (except by way of resale) and rely on modem banks for the purposes of terminating data calls which have been provided across a PSTN infrastructure. Though ISPs operate ISP modem banks, they are not considered to be interconnected with Telecom's fixed PSTN.

Liable Persons Summary

242. The liable persons for the purposes of this determination are:

[34] Kordia was known as Broadcast Communications Limited (BCL)

- TelstraClear New Zealand Limited;
- Vodafone New Zealand Limited;
- Compass Communications Limited;
- CallPlus Limited;
- WorldxChange Communications Limited;
- TeamTalk Limited;
- ihug Limited; and
- Woosh.

243. The calculation of the amount payable by each liable person in relation to the TSO instrument is in accordance with the formula set out in section 93. In the case of the TSO Deed the formula requires the quantification of the amount of the liable revenue of each liable person; and the liable revenue of the TSP (in this instance, Telecom).

Audit Reports

244. In its liable revenue instructions the Commission required that liable persons provide a report prepared by a qualified auditor that includes a statement of whether or not all the information provided complies with all the Commission's requirements. In order to provide more assurance when liable persons have significant liable revenue and the resources to pay for a more thorough audit, the Commission required Telecom and liable persons that are listed companies to provide a 'long form audit engagement report'. All other liable persons were requested to provide, as a minimum, an 'audit engagement report'.

Liable Revenue

245. For the reasons set out in the 2002/2003 TSO Determination, the Commission considers that the net revenues interpretation best gives effect to the purpose set out in section 18. It is superior to the retail revenue approach because it minimises the risk of deterring the resale of retail services. The net revenue approach is therefore most likely to promote competition in telecommunications markets for the long-term benefit of end-users within New Zealand. The Commission acknowledges that the net revenue approach may raise the costs of vertically integrated infrastructure providers in comparison to the retail revenue alternative. The Commission has weighed these competing effects, and on balance concludes that the net revenue approach should be adopted.

Deduction of payments to non-liable persons

246. The net revenue approach eliminates liable revenue generated from intra-industry sales, by deducting from gross revenue any amounts payable to other carriers for the provision of services that are telecommunications services. However, this does not necessarily mean that all payments to other carriers for telecommunications services are deductible. Deductibility needs to be considered in the context of the pool of industry revenue that the Commission is attempting to measure. For TSO purposes, the relevant pool of revenue is that generated by liable persons from supplying telecommunications services to anyone who is not a liable person. Only amounts payable to other liable persons for telecommunications services should, therefore, be deductible.

247. In some instances, telecommunications services are purchased from a non-liable person acting as an intermediary between a liable upstream provider and a liable downstream provider. In prior TSO determinations, the Commission allowed deductibility for all payments to non-liable persons for the provision of services that are telecommunications services provided by means of that entity's PSTN or by means that primarily rely on the existence of Telecom's PSTN. On further consideration the Commission has decided that this approach is too broad and that the rule should be more specific. The Commission also understands that the opportunity to use refile type arrangements to reduce costs has largely gone.

248. The Commission has allowed a deduction for amounts payable to non-liable persons for the purchase of telecommunications services when the services are provided by means of another liable person's PSTN or by means that rely primarily on Telecom's PSTN and so the non-liable person has purchased the service from a liable person or from Telecom.

Weighted revenues

249. Under section 85(1), the Commission, may use a weighted revenue basis to determine the amount payable by a liable person towards the TSO net cost. Section 85(3) states that a weighted revenue basis involves the following steps:

(a) identifying categories of telecommunications services that are likely to have the same market elasticity of demand;

(b) estimating the market elasticity of demand for each category of telecommunications services by using a recognised econometric method or other recognised estimation method.

250. The Commission considered and rejected the use of a weighted revenue basis, while noting that the issue could be reconsidered in future determinations if sufficiently robust and reliable data became available. The Commission is not aware of any new data on demand elasticities that would allow the Commission to adopt a weighted revenue approach.

Consistency of revenue information

251. To qualify as liable revenue under section 92(b)(i), the revenue must be received by the liable person from providing telecommunications services either by means of its PSTN, or by means that rely primarily on the existence of Telecom's PSTN.

252. The Commission considered the meaning to be given to the words 'by means of' in Decisions 497 and 525,[35] and concluded that 'by means of' requires a meaningful or not insignificant participation by some component of a PSTN operated by that person in provision of the service. Liable revenue accordingly includes revenue received by a liable person from providing telecommunications services through meaningful or not insignificant participation of a component of a PSTN operated by that person in providing the service.

253. Liable revenue also includes revenue received by a liable person from providing telecommunications services by means that rely primarily on the existence of Telecom's PSTN.

Calling card revenue

254. The Commission considers that liable revenue includes calling card revenue from calls which are not switched by a liable person. Such revenue is received by the liable person from providing telecommunications services that rely primarily on the existence of Telecom's PSTN and the fixed network ubiquity arising from the extensive and near universal nature of Telecom's PSTN.

Inbound roaming revenue

255. The Commission considers that revenue from roaming of overseas mobiles on New Zealand mobile networks is liable revenue because it is a telecommunications service provided by means of the New Zealand mobile carriers' PSTN.

Confiscated prepay credits

256. Prepay mobile calling is a telecommunications service that is provided by means of a mobile operator's PSTN. The operator sells this service by selling fixed amounts of prepay credits that have an expiry date, and the value of the credit sold must be counted as liable revenue. The Commission considers there should not be a deduction on the basis that some of the credit remains unused by the end-user before its expiry date.

Cost of handsets

257. Revenue from the sale of a mobile handset, which is not recovered through mobile access and calling charges, is not liable revenue as it does not satisfy the tests in section 92(b)(i) relating to the provision of telecommunication services by means of a liable person's PSTN or by means that rely primarily on the existence of Telecom's PSTN.

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[35] Paragraph 84 of Decision 525, Determination on the TelstraClear Application for Determination for 'Residential Wholesale' Designated Access Service.

258. The access and calling revenue received by a mobile operator is liable revenue as it is revenue received from providing telecommunication services by means of the operator's PSTN. Whether the operator treats some portion of its access and calling revenue as attributable to the cost of handsets is not relevant and does not alter the nature of the revenue for the purposes of section 92(b)(i). This is consistent with the Commission's net revenue approach which only eliminates revenue generated from intra-industry sales, and does not exclude other costs that are recovered through mobile calling or subscription charges.

TSO Charge Payable by Liable Persons

259. Section 92 requires the TSO final determination to disclose: 92(b)(i) the revenue amounts that will be used to calculate the TSO charge payable by each liable person; 92(a)(ii) the revenue amounts that will be used to calculate the TSO charge payable by Telecom; 92(f) the amount payable by each liable person in relation to the TSO instrument; and 92(g) the amount payable by each person in relation to the TSO instrument to the TSP for the lost of the use of the amount in 92(f).

260. The following table shows the liable revenue amounts determined by the Commission from the information provided by liable persons and Telecom as at the date of determination, and the resulting allocation of the TSO net cost.

Table 8: Reported Carrier Liable Revenues and TSO Charge for 1/7/2005-30/6/2006

2005/2006	Liable Revenue ($)	% of total	TSO Charge ($)	Loss of use of money ($)	TSO charge Payable to Telecom ($)
Telecom	2,710,813,000	68.548%	53,640,865		
Vodafone	995,896,000	25.183%	19,706,532	TBA	TBA
TelstraClear	227,176,000	5.745%	4,495,300	TBA	TBA
WorldxChange	8,595,729	0.217%	170,090	TBA	TBA
Ihug	8,381,471	0.212%	165,850	TBA	TBA
CallPlus	2,712,960	0.069%	53,683	TBA	TBA
Teamtalk	579,793	0.015%	11,473	TBA	TBA
Woosh	276,157	0.007%	5,465	TBA	TBA
Compass	177,992	0.005%	3,522	TBA	TBA
Total	3,954,609,102	100.000%	78,252,780	TBA	TBA

TSO COMPLIANCE

261. The Commission is required under section 80 to make an annual assessment of the TSP's compliance with the TSO instrument. Section 80 of the Act provides that:

> Not later than 60 working days after the end of each financial year of a TSP under a TSO instrument, the Commission must—
>
> (a) assess the TSP's compliance with the TSO instrument during that financial year in accordance with any process set out in the TSO instrument; and
>
> (b) notify the TSP and the Minister in writing of any non-compliance by the TSP with the TSO instrument.

262. Clause 21 of the TSO Deed requires Telecom to:

> 21.1.1 report to the Crown and (pursuant to the Act) the Commerce Commission at least annually on its performance against the local residential telephone service quality measures;
>
> 21.1.2 disclose to the Crown and (pursuant to the Act) the Commerce Commission the methodology (including proxy sampling methods), the relevant calculations and reasonable supporting information for the relevant calculations;
>
> 21.1.3 have that methodology and its implementations audited for its appropriateness to achieve a sensible and pragmatic, but robust, analysis of performance against the local residential telephone service quality measures; and
>
> 21.1.4 disclose that audit report to the Crown and (pursuant to the Act) the Commerce Commission.

263. Telecom has provided sufficient information to demonstrate its compliance against TSO service quality measures (the 'Service Quality Measure Report') for the TSO period.

264. The Commission noted that Telecom's measurement methodology involved sampling and approximations. While accepting that compliance had been demonstrated, the Commission continues to reserve its position on the appropriate measurement methodology for future periods.

265. The Commission has notified Telecom and the Minister of Communications that the Commission accepts that the TSO service quality measures were met for the TSO period.

DATED this 9 July 2007

Douglas Webb
Telecommunications Commissioner

APPENDICES

APPENDIX 1: TSO MODEL INPUTS, UPDATES AND CHANGES

Model Architecture

266. The TSO model is an aggregate of models and processes, this is shown on Figure 2: TSO System Drawing.

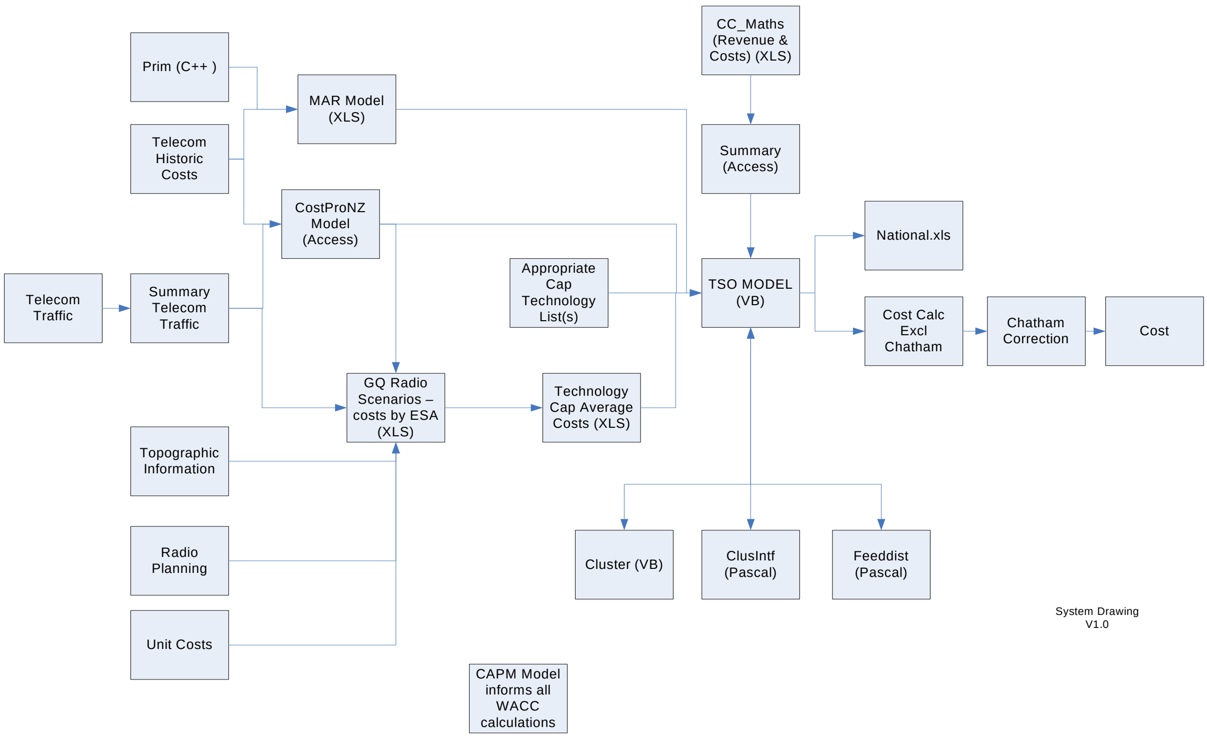

Figure 2: TSO System Drawing

267. Description of the main models:

- CAPM - Capital Asset Pricing Model
- Clusinf – cluster interface – this program was sourced from the FCC -it interfaces between the data requirements of the cluster program and the feeddist program (model source location ‘C:\hcpm\model_lib\fcc hcpm code’).
- Cluster – this program was sourced from the FCC – it assembles clusters of customers for processing by the HCPM system (model source location ‘C:\hcpm\model_lib\fcc hcpm code’).
- CostProNZ model – this model uses PSTN unit costs, a network topology to calculate the costs of carrying traffic (model source location ‘c:\hcpm\model_lib\Cost_Pro_NZ’).
- Feeddist – feeder and distribution design and cost calculation this program was sourced from the FCC (model source location ‘C:\hcpm\model_lib\fcc hcpm code’).
- GQ Radio Scenarios – this model assesses the costs to provide various radio based PSTN services (model source location ‘c:\hcpm\model_lib\GQ_radio_model’).
- MAR Model – Multiple Access Radio – this model takes simple information and produces a tilted annuity cost (model source location ‘c:\hcpm\model_lib\MAR_model’).
- Prim – this model calculates a Prim distance placing a limit on the distribution cabling cost for the distribution side of the MAR model (model source location ‘c:\hcpm\model_lib\prim’)

- Technology Cap Average Costs MAR – this model takes various costing scenarios and provides an average cost to be used in the TSO model ‘c:\hcpm\model_lib\MAR_model’.
- Technology Cap Average Costs MT & WLL – this model takes various costing scenarios and provides an average cost to be used in the TSO model (‘c:\hcpm\model_lib\GQ_radio_model’.
- TSO model – this model is the heart of the system. It calls on PSTN design information and can cap the traditional PSTN design with the radio caps. The model assesses the minimum avoidable cost ‘c:\hcpm\model_lib\TSO_optomisation’.

Update of the TSO 2003/2004 program Optimisation Algorithm

268. In the 2003/2004 TSO determination, the Commission considered a submission by NERA that the technology with the lowest replacement costs should be selected, rather than the technology with the lowest annualised cost.

269. A comparison of competing technologies on the basis of their upfront capital costs (ORCs) is valid only if all other features of the two technologies are assumed to be the same, or at least to be reasonably similar. These include the expected lives of the assets, the expected operating costs over the life of the assets, and the expected quantity and quality of service. These conditions were not explored in the examples given in the NERA submission. If these conditions are not met, then a comparison based on ORCs alone will be incomplete and will require an appropriate adjustment to be made. For example, if there is a material difference in operating costs then the comparison should be based on the present value of the sum of the (upfront) capital and ongoing operating costs. If there is a material difference in the economic lives of the assets, then the standard approach is to compare the present values of the technologies assuming they are repeated until a common terminal date is reached. This common terminal date concept is demonstrated on Figure 3.

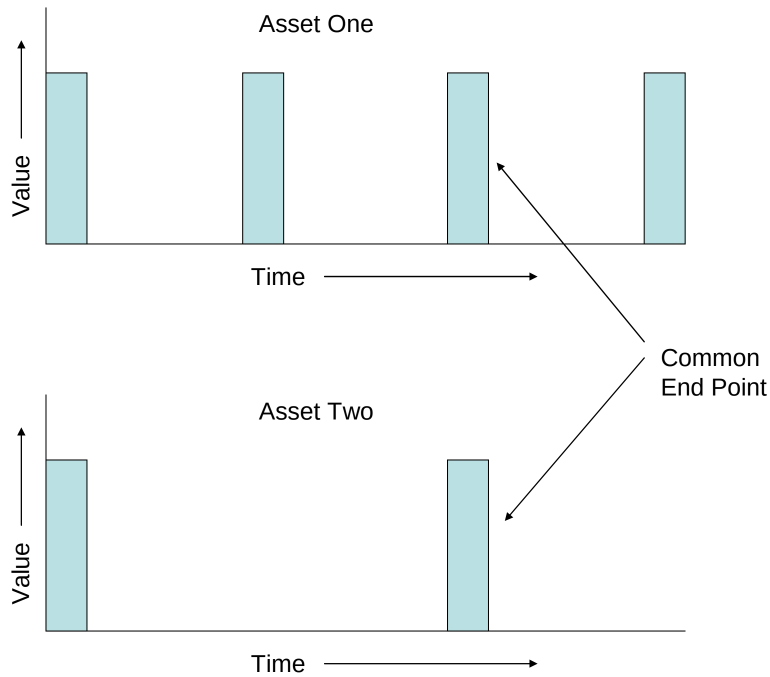

Figure 3: Two Investments with a Common Terminal Date

270. The Commission has modelled telecommunication assets using the parameters in ‘Table 36: HCPM Model Technologies Asset Economic Profile Information’. These

have been used in the HCPM model, the model that simulates Telecom's access network usage costs.

271. A complicating factor in comparing baskets of technologies e.g. a GSM cap proposal is that each technology is in itself composed of technologies. Each of these lower level technologies has its own characteristic life time. In the case of the HCPM model the lifetimes of the technologies are [ ], [ ], [ ], [ ], [ ], [ ], [ ], [ ] and [ ] years[36]. The common end point of this time series is at 7,490,700 years i.e. after this time all the technologies will have their first common period when they are all at the end of their respective life periods.

272. The NPV formula is presented below for a series of investments V_0 with a tilt of α.

Equation 2: NPV Formula Evaluated over a Set Number of Lifetimes

$$NPV = \sum_{t=0}^{life\_times} \frac{V_0 * (1+\alpha)^{t*N}}{(1+WACC)^{t*N}}$$

Where:

α	=	nominal tilt
life_times	=	number of PV terms to be added, each representing a technology life time of 'N' years
N	=	period of a life time (years)
NPV	=	Net Present Value
V_0	=	year 0 ORC
WACC	=	WACC (Weighted Average Cost of Capital)
t	=	counter of lifetimes

273. The NPV is a numerical series involving the summation of a number of present value terms. Computationally the calculation of NPV for a large number of terms is inefficient. As the number of terms included in the summation is made arbitrarily large then the NPV summation will asymptote to a final value, referred to as "NPV∞".

274. Recognising the tilted NPV as a geometric series and summing over all the terms from 0 to infinity is mathematically equivalent to:

Equation 3: NPV over an Infinite Number of Lifetimes

$$NPV\infty = \frac{V_0}{1-\left(\frac{1+\alpha}{1+WACC}\right)^N}$$

Where:

α	=	nominal tilt
N	=	period of a life time (years)
NPV∞	=	Net Present Value of a series extended to infinity
V_0	=	initial ORC
WACC	=	WACC (Weighted Average Cost of Capital)

275. This is both computationally efficient and is not troubled by the concept of endpoints. It provides a consistent basis to compare the NPV of different technologies.

[36] Refer to Table 36

Abbreviations

276. The use of the following abbreviations is restricted to this section as they have not been noted in the document's list of abbreviations:

dist	Distribution – cabling from a central cabinet to customers
ugd	Plant involving ducts and manholes
bur	Direct buried cable
cop	Copper cable
aer	Aerial cable
struc	Structural costs e.g. digging the hole for place cable underground or erecting the poles to carry aerial cable
term	Terminal
t1	A PSTN transport mechanism whereby multiple PSTN voice circuits are aggregated into a larger multiplexed 'pipe'.

Model Architecture

277. Pictorially the model architecture used in the TSO 2003/2004 determinations may be viewed as: Figure 4 below.

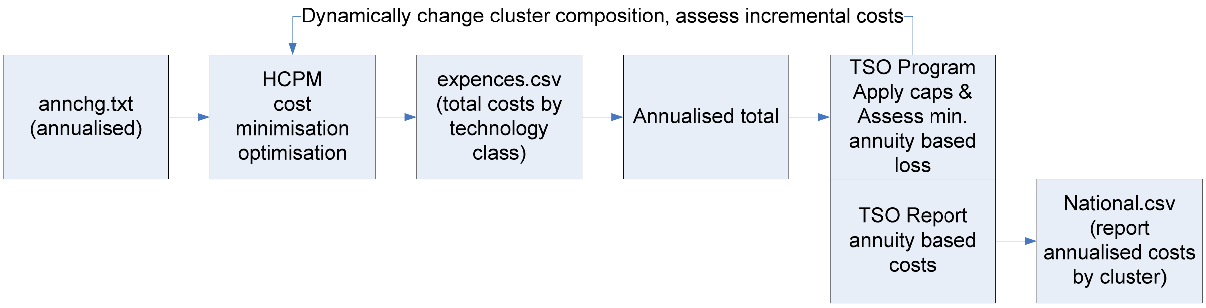

Figure 4: TSO/HCPM model as used in TSO 2003/2004

278. Prior to the TSO 2004/2005 the 'annchg.txt'[37] file was populated with weightings allowing the HCPM model to report in 'expense.csv' and 'exptot.csv' on the annualised expenses. The TSO program would then act to minimise the total annualised cost of the network.

279. The 'annchg.txt' input was updated for TSO 2004/2005 with weightings to cause the HCPM system to report on NPV, the TSO program would then act to minimise the total NPV. Other system inputs such as net revenue, and the radio cap values were augmented to provide both the annualised and the equivalent NPV∞ cost. The radio caps were updated based on the caps cost drivers including tilt and asset lives, while the other inputs such as the net revenue used were assumed to be constant in nominal terms (i.e. to stay at the same nominal level into the future).

280. The updated architecture is shown below.

[37] A brief description of this file's function and of other similar files is held in 'Table 39: HCPM Default Inputs'.

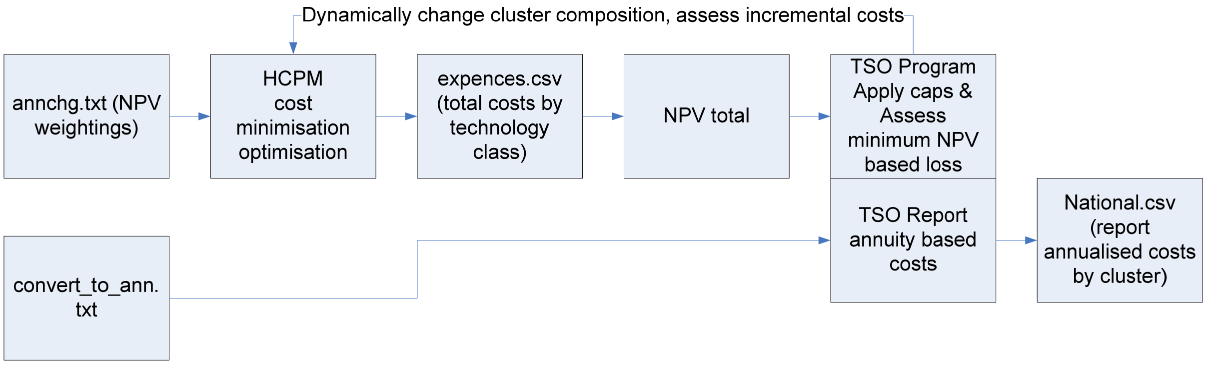

Figure 5: TSO/HCPM model Architecture TSO 2004/2005

281. Internally the update in the TSO Visual Basic ("VB") code has been accomplished by making the variables dealing with costs carry two values; one dealing with NPV, and the other its equivalent annualised cost. Any decision made as part of the optimisation would only be informed by NPV, while any calculation of the TSO cost would only be informed by the annualised cost. This has the effect of minimising the NPV but reporting the associated annualised cost.

Annuity, NPV Coefficients & Converting from NPV to Annuity

282. By changing the 'annchg.txt' coefficients the system can be relatively easily converted to reporting NPV∞ costs. The system made up of the TSO and HCPM models will minimise the NPV costs. This has met part of the upgrade requirement but does not allow reporting of the annualised costs. The cost report from the HCPM model is now composed of the NPV costs of 18 different asset classes. Due to different characteristics such as tilt and asset lifetimes it is not possible to reverse engineer the total NPV to report the annualised costs. It is however possible to reverse engineer each of the 27 different NPV cost items in 18 different asset classes to establish their annualised cost. This is developed in Equation 4 to Equation 6 below.

Equation 4: Annualised Cost of Capital Coefficient

$$\left(\frac{1+r}{1+\alpha}\right)^{u} \frac{(1+\alpha)^{t-1} * (r-\alpha)}{1-\left(\frac{1+\alpha}{1+r}\right)^{N}}$$

Where:

α	=	Nominal rate of change of the optimised replacement cost of the asset
u	=	time to build in years
r	=	rate of return on capital
t	=	particular year in the economic cost of the asset
N	=	economic life of the asset

283. An asset's ORC is multiplied by a NPV factor such as is given by Equation 5 below, to derive its NPV. This equation is used to populate 'annchg.txt'.

Equation 5: NPV Summed to Infinity Coefficient

$$\frac{1}{1-(\frac{1+\alpha}{1+WACC})^{N}}$$

Where:

α	=	Nominal tilt
N	=	The period of a life time (years)
WACC	=	WACC (Weighted Average Cost of Capital)

284. Given the individual NPV cost for each of the 27 technologies on Table 10 it is possible to reverse engineer the cost quantity and to obtain the corresponding annuity. This is achieved as follows:

Equation 6: Conversion of HCPM NPV Output to an Annuity

$$Annuity_i = NPV\infty_i * (AnnuityCoefficent_i \,/\, NPV\infty\_Coefficent_i)$$

Where:

i	=	Technology class i
Annuity Coefficient	=	The factor multiplying the original value V (refer to Equation 9)
NPV∞ Coefficient	=	The factor multiplying the original value V (refer to Equation 5)

285. The individual costs are able to be reverse engineered to establish their annualised costs. The term $(AnnuityCoefficent_i \,/\, NPV\infty\_Coefficent_i)$ has been calculated and is stored in 'convert_to_ann.txt'. This term is available to convert the NPV totals presented in 'expense.csv. to annualised quantities. These are in turn used by the program to report on the annualised cost of the investment.

286. The program suite has previously had to deal with a single concept that of a tilted annuity. The suite minimised this cost and also reported using this cost. This update meant that he program has to simultaneously manage both NPV concepts and yet retain the equivalent amount representing the annuity.

287. This "bilingual" property has been achieved through the use of a 'type' variable. Where previously any cost information would have involved an annuity it now has two "properties" that of annuity and NPV. The required quantities have been promulgated throughout the program. Where required for optimisation, NPV has been used to make decisions. Where required for costing the TSO the annuity has been used.

288. The program has been updated by using Table 10 and substituting the weightings in 'annchg.txt' from those of Equation 4 to those of Equation 5. The NPV and annuity inputs from the radio cap have been entered directly. The system at this stage will minimise NPV and report on this minimised NPV.

289. This updating of the 'annchg.txt' file has converted the system to optimising by minimising the NPV. At this point and without further modification all the expense reporting would be in terms of NPV. This is not useful for reporting an annualised expense. It is now necessary to change the system allowing it to report on annualized costs.

290. The system comprising the TSO & HCPM programs needs look up tables to calculate the NPV∞ and the corresponding annuity. The HCPM system uses the weightings in 'annchg.txt' to produce NPV∞ which is reported in 'expense.csv'. The TSO program read the NPV information in 'expense.csv' and uses the coefficients in 'convert_to_ann.txt' to produce annuities.

Reporting via 'expense.csv'

291. The HCPM model's main expense information is written to 'expense.csv'. A summary is also written to 'exptot.csv'. File 'exptot.csv' is populated with the total expense of a cluster network. Previously the 'exptot.csv' file was a main output from the HCPM model to the TSO model. The expense quantities output are determined by the nature of the weightings in 'annchg.txt'. If the weightings are annuity based then the output costs are in terms of annuities; if they are NPV based then they output quantities are NPV.

292. Post the modification the 'exptot.csv' file is still produced by the HCPM program. It is a NPV, and is the sum total of 27 cost items. The total is a single figure that cannot be reverse engineered to deduce either the individual ORC or an equivalent annuity. The total could be used in the optimisation but is not able to be used to provide information on annuities. The expense file, is however, able to be used. The 'expense.csv' file in this configuration lists 27 HCPM expense items in Table 9, and also identified their asset profiles.

Table 9: HCPM 'expense.csv' Items

ref	HCPM Expense Items	Asset Profile
0	dist ugd cable	ac_ugd_cop
1	dist bur cable	ac_bur_cop
2	dist aer_cable	ac_aer_cop
3	dist ugd structure	ac_ugd_struc
4	dist manhole cost	ac_manhole
5	dist aer structure	ac_aer_struc
6	dist bur structure	ac_bur_struc
7	Fiber terminal cost	ac_fib_term
8	t1 terminal cost	ac_t1_term
9	t1 repeater cost	ac_repeater
10	secondary tterm cost	ac_t1_term
11	interface cost	ac_fdi
12	drop_cost	ac_drop
13	drop terminal cost	ac_drop_term
14	nid_cost	ac_nid
15	per line cost (lines)	ac_nid
16	feed ugd cable	ac_ugd_cop
17	feed bur cable	ac_bur_cop
18	feed aer cable	ac_aer_cop
19	feed ugd fiber	ac_ugd_fib
20	feed bur fiber	ac_bur_fib
21	feed aer fiber	ac_aer_fib
22	feed ugd structure	ac_ugd_struc
23	feed manhole cost	ac_manhole
24	feed_bur_structure	ac_bur_struc
25	feed aer structure	ac_aer_struc
26	feed splice cost	ac_fib_splice

293. Each of the 27 NPV cost items are able to be read from 'expense.csv', their total provided as a total NPV (this is the same total as the 'exptot.csv' file. Each of the NPV is able to be reverse engineered to form an annuity. The total of these annuities is then calculated and used to inform the TSO models annualised output.

294. The parameters in 'annchg.txt' are derived using Equation 5 plus the asset profile information in Table 10. These parameters are also used when using Equation 6 to populate 'convert_to_ann.txt'. They are directly used when producing the NPV, annuity or the reverse engineered weightings

Table 10: HCPM Asset Profiles

ref	Asset Profile	Asset life	Time to Build	Nominal price tilt
0	ac_ugd_cop	[ ]	0.5	[ ]
1	ac_bur_cop	[ ]	0.5	[ ]
2	ac_aer_cop	[ ]	0.5	[ ]
3	ac_ugd_fib	[ ]	0.5	[ ]
4	ac_bur_fib	[ ]	0.5	[ ]
5	ac_aer_fib	[ ]	0.5	[ ]
6	ac_ugd_struc	[ ]	0.5	[ ]
7	ac_bur_struc	[ ]	0.5	[ ]
8	ac_aer_struc	[ ]	0.5	[ ]
9	ac_manhole	[ ]	0.5	[ ]
10	ac_t1_term	[ ]	0.5	[ ]
11	ac_fib_term	[ ]	0.5	[ ]
12	ac_fdi	[ ]	0.5	[ ]
13	ac_fib_splice	[ ]	0.5	[ ]
14	ac_drop	[ ]	0.5	[ ]
15	ac_drop_term	[ ]	0.5	[ ]
16	ac_nid	[ ]	0.5	[ ]
17	ac_repeater	[ ]	0.5	[ ]

The restricted information in the above table is CCRI.

295. The Commission has supplied the code suite that has as been used for the TSO 2003/2004. Thus allowing a comparison by reviewers with the suite used in the draft 2005/2006 suite.

ADSL model

296. Telecom has provided a model and data to calculate the net revenue by ESA from their ADSL service. The model is based on two sub models: the first models Telecom's ADSL access network; the second models Telecom's core network.

297. The Telecom ADSL net revenue model is available in 'C:\cc_tso_net_cost_tree'.

Modelling

298. The modelling is performed by two main program suites. The HCPM suite has is a public domain program to design an efficient PSTN access network. The TSO is an optimisation program which investigates the possibility of providing service using technologies that are not available in the HCPM model. The HCPM model then determines clusters of customers that are incrementally non profitable.

HCPM Modelling

299. The HCPM program uses 18 different asset classes refer to Table 10: HCPM Asset Profiles . These range from copper to fibre cables to manholes and duct lines. The unit cost for these technologies is calculated using inputs from: 'annchg.txt' ; and various ORC costs directly entered from various tables.

300. The net cost for any particular solution is calculated by:

$$Cost = \sum_{i=1}^{n} w_i * n_i * ORC_i$$

Where:

Cost = the cost of the solution (NPV or annuity)

w_i = a weighting to convert an ORC based cost to either a NPV or to an annuity
n_i = a measure of quantity recording the number of unit of a technology that are deployed
ORC_i = the Optimised Replacement Cost for a unit of technology 'i'

ADSL Modelling and Net Revenue

301. Telecom has provided data and models of their ADSL costs and revenues at an exchange level. These models are available on the distribution disk at 'C:\cc_tso_net_cost_tree\0405' and at 'C:\cc_tso_net_cost_tree\0506'. These net revenues have been treated as a revenue stream and have been aggregated on 'C:\cc_tso_net_cost_tree \ revenue_lines_all_q_all_esa.xls'

302. Liable Persons have been invited to comment on Telecom's ADSL model and statement of net revenue[38]. These comments were provided to Telecom. Parties comments and Telecom's response is now appended to the ADSL model. They are physically located on the distribution disk[39] and are provided as part of Telecom's ADSL model and net revenue. Liable parties (& Telecom) having already reviewed the ADSL model and having the benefit of Telecom's response to their questions should gain a greater appreciation of the ADSL model and net revenue information.

Terrain Related Inputs

303. HCPM terrain information has been derived from ESA trenching difficulty analyses supplied by Telecom. This data has been collected from Telecom's regional outside plant contractors and is used as an averaged structure cost multiplier for each ESA in Telecom's TSO cost model.

304. For each ESA, terrain information is in the form:

Table 11: Sample ESA Terrain Information

ESA	I/T Hard	I/T Med	I/T Easy	O/T Hard	O/T Med	O/T Easy	Rural ind	I/T	O/T
[ ]	0.05	0.95	0	0.1	0.3	0.6	1	0.3	0.7
[ ]	0.2	0.8	0	0.2	0.6	0.2	0	0.81	0.19
[ ]	0.05	0.95	0	0.1	0.3	0.6	1	0.05	0.95
[ ]	0.05	0.95	0	0.35	0.35	0.3	0	0.4	0.6
[ ]	0	0	0	0.2	0.4	0.4	1	0	1
[ ]	0	0	0	0.1	0.2	0.7	1	0	1
[ ]	0.05	0.95	0	0.15	0.4	0.45	1	0.05	0.95
[ ]	0	1	0	0.2	0.3	0.5	1	0.05	0.95
[ ]	1	0	0	0	0	0	0	1	0

305. The Telecom contractor information is interpreted as follows:

- I/T Hard, I/T Med and I/T Easy are the probabilities of striking hard medium or easy conditions for trenching/cable laying in the 'In Town' component of each ESA
- O/T Hard, O/T Med and O/T Easy are the probabilities of striking hard medium or easy conditions for trenching/cable laying in the 'Out of Town' component of each ESA
- Rural ind is an indicator for principally rural ESAs (1 for rural, 0 for urban)
- I/T O/T are the In Town and Out of Town network weightings for each ESA

[38] Commerce Commission, *Update on Local Calling TSO 2004/05 and 2005/06,* letter 13 December 2006
[39] C:\cc_tso_net_cost_tree\RequestElaborations

306. The Telecom terrain categories are defined:

- Easy – areas where it is possible to mole-plough
- Medium - includes trenching of footpath (small to medium back hoe or chain digger), directional drilling or 'prerip' with mole-plough in medium traffic areas.
- Hard - includes trenching roadway (large back hoe), difficult terrain (rock saw) and CBD/high traffic areas

307. The corresponding three sets of HCPM structure costs are:

- Normal
- Soft
- Hard

308. As discussed in the 2002/2003 TSO determination[40], the Commission does not use the FCC geophysical parameters to determine trenching difficulty. The FCC approach is not appropriate for New Zealand, where road reserve and road berm access conditions have proven to be the key trenching cost drivers.

309. For the purposes of TSO modelling, the Commission has mapped Telecom's easy, medium and hard terrain categories onto HCPM normal, soft and hard categories respectively. The mapping is achieved by manipulating specific cluster terrain parameters:

- Bedrock Depth
- Rock Hardness
- Soil Consistency
- Water Table Depth
- Minimum Slope, and
- Maximum Slope

310. Each cluster is forced to use a particular set of structure costs by setting its terrain parameters:

Table 12: Cluster Terrain Parameters

Costs	Bedrock	Hardness	Soil	Water Table	Min Slope	Max Slope
Normal (Easy)	60	Normal	0	5	1	1
Soft (Medium)	10	Soft	1	5	1	1
Hard (Hard)	10	Hard	1	5	1	1

311. Water table and slope triggers are not used explicitly, but combined into the definitions of Easy Medium and Hard.

[40] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for Period between 1 July 2002 and 30 June 2003*, March 2005, para 281, 2002/2003 Terrain Approach

Terrain Modelling Approach

312. For the 2002/2003 TSO Determination TelstraClear engaged experts Dr David Bell and Mr Ranald Ducat to undertake a terrain and trenching difficulty analysis of several high TSO cost ESAs. The Commission has considered the results and recommendations arising from the Bell-Ducat survey in some detail.[41] The Bell-Ducat model could be used to inform a discussion on calibrating the simpler Commerce Commission model.

313. The Commission recognised that the Bell-Ducat methodology has usefully identified the key trenching cost drivers in rural New Zealand and makes progress towards defining a framework for the objective characterisation of trenching conditions in road reserves.

314. The methodology has been tested on a subset of high TSO cost ESAs and does not yet provide a comprehensive database of results for New Zealand.

315. The Telecom Contractor information remains the only comprehensive and consistently applied database of terrain for all ESAs and the Commission considers that Bell-Ducat assessment of high TSO cost ESAs is not sufficiently robust to replace the terrain profiles or costs adopted for the 2001/2002 TSO Determination.

316. The Commission has continued to use the terrain data as was used in the 2002/2003 determination. If any party were to provide a national database providing demonstratively improved modelling outcomes then the Commission would consider the benefits of using this data to recalibrate the Commission model.

Terrain Allocation

317. Telecom trenching difficulty information is used to sub-divide allocation of terrain into the four categories:

- Rural In Town
- Rural Out of Town
- Urban In Town
- Urban Out of Town

318. Each category is treated separately for the purposes of HCPM cluster terrain allocation.

Rural In Town

319. Telecom trenching difficulty information indicates that the ‘Easy’ classification is not used for any ‘In Town’ network clusters (i.e. probability of ‘Easy’ = 0 in all cases). Using the definitions supplied by Telecom, this implies that ‘mole-plough’ cable laying techniques cannot be used for rural ‘In Town’ areas, requiring in all instances more expensive laying techniques.

320. Cluster #1 of an HCPM rural ESA is mapped to ‘Rural In Town’ trenching probabilities. In many instances, this cluster includes areas which could be reticulated using modern mole-plough laying techniques. This issue is addressed by adjusting HCPM trenching cost estimates for rural Medium (HCPM Soft) areas to allow for less expensive laying techniques (see trenching rate inputs below).

[41] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for Period between 1 July 2002 and 30 June 2003* March 2005,, Appendix 7.

321. Rural In Town cluster terrain classification is set to HCPM Soft unless the probability of Hard exceeds the probability of Soft.

Rural out of Town

322. Rural Out of Town clusters (2 to n) are assigned terrain classifications based on Out of Town trenching difficulty probabilities as follows:

- Number of Normal (Easy) Clusters (N) is calculated by rounding up (OTEasy * (n-1))
- Number of Soft (Medium) Clusters (S) = Round((OTMed / (OTMed + OTHard)) * (n – 1 – N), 0)
- Number of Hard Clusters = n – 1 – N – S

Urban

323. Terrain classification for urban ESAs uses the rural procedure if average line density is less than 650 lines per square mile. If density is above this value, cluster terrain classification is set to Medium (HCPM Soft) unless the ‘In Town’ probability of Hard exceeds probability Medium. This process ensures that metro areas such as Auckland central and Wellington central retain an overall Hard classification. The following table provides statistics on terrain allocation to clusters:

Terrain Type	HCPM Hard	HCPM Soft	HCPM Normal
% Allocation	14	48	38

Engineering Inputs

Access Network Sharing

324. The Commission Commission’s estimate of access network sharing is stratified by customer density as follows:

Density	Sharing
Metro	15.30%
Urban/Suburban	4.19%
Rural	3.51%

325. Although sharing percentages are available on an ESA by ESA basis, these are difficult to apply in modelling, especially in rural ESAs where a single business location may be responsible for all non-PSTN circuit ends. Where rural non-PSTN circuits form a large percentage of total circuit ends, the high level of sharing indicated may not occur in practice due to the non-PSTN circuits being concentrated within a single cluster.

326. For this reason the Commission has adopted average sharing figures by customer densities, which are applied as cost reduction factors on the appropriate trenching costs.

Clustering Process Inputs

327. Cluster inputs are geocoded customer/demand information and control options and settings for the process of grouping customer locations into serving areas.

328. The HCPM ESA input files differ from Telecom's standard list of ESAs as listed in the following table:

Table 13: Mapping between Telecom Standard ESAs and HCPM Supplementary ESAs

ESA	Description
AKCE	CTY ESA is renamed AKCE - Auckland Central
AO1	AO1 is western Akaroa - former radio site
BM1	Blenheim 1 and 2 - remote costal areas
BM2	
DRF1	Darfield 1 - Arthurs Pass area
HBN1	Hastings 1, hill area south of Otamauri
KHO1	Kaikohe 1, area west of Taheke,
MKB	Millbrook ESA Missing from Telecom geo-data input, very small area included in Arrowtown - AW ESA
MUS	Manutuke South 20km south of MKE: Manutuke combined with MKE
OAU1	Otautau1, ex radio area north of Orawia
OTI	Otira - geocoded information not available, 20 lines north of AHP on state highway - use scaled AHP costs
PHA1	PAHIATUA 1, coastal Wairarapa adjacent to Alfredton
RNF1	RANFURLY 1, hill area south of Patearoa
RRR	RRR Ruatoria Rural combined with RUT Ruatoria
TG1	Motiti Island, off Tauranga coast - DMR. Use TG per line revenues
TSQ	TSQ Te Puia Springs West combined with TPS Te Puia Springs
WI1	Waipawa 1, coastal area south of Omakere
WR1	Whangarei 1, Pipiwai region
WTG	Waitangi, Chatham Island – partially modelled
WWS	Wairoa West, combined with Wairoa, WA

329. ESAs with a numerical qualifier (AO1, BM1 etc) are additional to Telecom's ESA list. These consist of small numbers of lines in remote areas which are assigned average revenues consistent with neighbouring ESAs for which Telecom has provided data.

330. Shaded ESAs in the table are removed from Telecom's standard ESA list due to lack of geocoding information or because they are very small nodes physically adjacent to a parent.

331. The physical ESA cluster files are slightly modified for this determination from those provided previously with the TSO model and databases. The Commission has added an additional character to the cluster information lines within the '*.clu' files as illustrated in bold:

<u>Previously:</u>

```
WC_code, Swx, Swy, CenX, Ceny, Company,,,,,,
AAI,173.256282369,-35.050691054,173.256282369,-35.050691054,TCNZ,,,,,,
Number of Lines (including special access):  998
Number of Clusters:  7
Run-time in Minutes:  0.0047

Cluster, X, Y, Lines, X1, Y1, X2, Y2, Bedrock, Hardness, Soil, WaterTbl, MinSlope,
MaxSlope, CB Number
1,0,0,373,546,-324,-2586,6912,10,SOFT,1,5,1,1,000dummyCB
2,21537,52795,86,29416,45736,11585,61712,10,HARD,1,5,1,1,000dummyCB
3,-18371,8938,141,-18393,8822,-15270,25240,10,SOFT,1,5,1,1,000dummyCB
```

```
4,23726,569,73,22403,1566,36201,-8830,60,NORMAL,0,5,1,1,000dummyCB
5,10906,10281,50,13309,8811,4745,11693,60,NORMAL,0,5,1,1,000dummyCB
6,35902,23703,85,36024,23785,25627,16780,60,NORMAL,0,5,1,1,000dummyCB
7,36567,62520,190,36532,62455,43154,74906,60,NORMAL,0,5,1,1,000dummyCB

X, Y, Cluster, Res, Bus

-1430,7891,1,1,0
19,923,1,1,0
-1108,-412,1,1,0
```

Modified:

```
WC_code, Swx, Swy, CenX, Ceny, Company,,,,,,
AAI,173.256282369,-35.050691054,173.256282369,-35.050691054,TCNZ,,,,,,
Number of Lines (including special access):  998
Number of Clusters:  7
Run-time in Minutes:  0.0047

Cluster, X, Y, Lines, X1, Y1, X2, Y2, Bedrock, Hardness, Soil, WaterTbl, MinSlope,
MaxSlope, CB Number
1,0,0,373,546,-324,-2586,6912,10,SOFT,1,5,1,1,000dummyCB,1
2,21537,52795,86,29416,45736,11585,61712,10,HARD,1,5,1,1,000dummyCB,2
3,-18371,8938,141,-18393,8822,-15270,25240,10,SOFT,1,5,1,1,000dummyCB,3
4,23726,569,73,22403,1566,36201,-8830,60,NORMAL,0,5,1,1,000dummyCB,4
5,10906,10281,50,13309,8811,4745,11693,60,NORMAL,0,5,1,1,000dummyCB,5
6,35902,23703,85,36024,23785,25627,16780,60,NORMAL,0,5,1,1,000dummyCB,6
7,36567,62520,190,36532,62455,43154,74906,60,NORMAL,0,5,1,1,000dummyCB,7

X, Y, Cluster, Res, Bus

-1430,7891,1,1,0
19,923,1,1,0
-1108,-412,1,1,0
```

332. Each cluster information line is now tagged with its original cluster number as the final character on the line. This does not impact the operation of HCPM, but enables tracking of original cluster numbers for improved reporting from the model. Note that use of previously provided cluster files in the current model version will result in incomplete reporting.

333. The key engineering inputs to the clustering process are:

- Copper distance limit for distribution cable, set to 7km (22,300 feet) for 0.63mm diameter cable. This figure is industry standard for delivery of telephony services, although it is sometimes exceeded with some accepted degradation of service quality in rural areas.

- Limit to the maximum number of lines ordinarily assigned to a single cabinet, set to 1800 lines. In particularly dense areas this limit may be exceeded.

334. The clustering inputs, with descriptions are summarised in:

Table 14: Cluster Inputs

Values	Description	Comments
150	Raster_Size	Micro-grid size for locating customers before clustering
22300	Distance_Limit	feet - maximum reach with .63mm cable = 7km
1800	Line_Limit	Nominal max number of lines per cabinet
80	Line_Fill	Determines cluster size before optimisation
5	Lines_per_Business	Used only with Census block input data
1	Cluster_Algorithm	Use the Divisive option
4	Optimization_Method	Auto-select optimal approach
1000	Maximum_populated_cells	Initial value for rasterisation process
0	Use_hcpm.mdb	Alternative ESA database format, not used
0	True-up_line_counts	Update demand for annual runs, not used
1	Lines_per_Residence	Used only with Census block input data
0	make_plot	Run time option – used only in interactive mode

Copper Cable

335. Costs in the tables below include material, placing, splicing and engineering. Entries in black are direct data values supplied by parties. The source is noted in the Comments area of the Table. The input values are unchanged from the 2001/2002 determination, but modelled capital charges track the tilt value for Copper Cable through use of ‘t = 5’ in the annualisation formula.

336. Where parties do not use a particular size of cable, the cost value (in **blue**) has been interpolated or extrapolated from supplied data. This approach is consistent with parties' estimation of cable jointing/splicing costs and scales placement and engineering costs, particularly for the larger cable sizes.

337. The Commission notes that cables above 1200 pair capacity are unlikely to be used in modelling for a New Zealand network outside of metro and highly dense urban environments.

Table 15: Cost of 0.63mm (24 Gauge) Copper Cable

Size	UG	Buried	Aerial	Comments
4200	$[ ]	$[ ]	$[ ]	Price per foot for underground, buried and aerial copper
3600	$[ ]	$[ ]	$[ ]	0.63mm cable prices NZ
3000	$[ ]	$[ ]	$[ ]	
2400	$[ ]	$[ ]	$[ ]	
2100	$[ ]	$[ ]	$[ ]	
1800	$[ ]	$[ ]	$[ ]	
1200	$[ ]	$[ ]	$[ ]	UG TCNZRI
900	$[ ]	$[ ]	$[ ]	
600	$[ ]	$[ ]	$[ ]	
400	$[ ]	$[ ]	$[ ]	UG TCNZRI
300	$[ ]	$[ ]	$[ ]	UG TCNZRI
200	$[ ]	$[ ]	$[ ]	UG TCNZRI, B mod TNZRI, A TCRI
100	$[ ]	$[ ]	$[ ]	UG TCRI, B mod TCNZRI, A TCRI
50	$[ ]	$[ ]	$[ ]	UG TCRI, B mod TCNZRI, A TCRI
25	$[ ]	$[ ]	$[ ]	UG TCRI, B mod TCNZRI, A TCRI
18	$[ ]	$[ ]	$[ ]	
12	$[ ]	$[ ]	$[ ]	
6	$[ ]	$[ ]	$[ ]	B mod TCNZRI 7pr
1	$[ ]	$[ ]	$[ ]	

Table 16: Cost of 0.4mm (26 Gauge) Copper Cable

Size	UG	Buried	Aerial	Comments
4200	$[ ]	$[ ]	$[ ]	Price per foot for underground, buried and aerial copper
3600	$[ ]	$[ ]	$[ ]	0.4mm NZ
3000	$[ ]	$[ ]	$[ ]	Used the 24 Gauge aerial as no data for 0.4mm
2400	$[ ]	$[ ]	$[ ]	
2100	$[ ]	$[ ]	$[ ]	
1800	$[ ]	$[ ]	$[ ]	
1200	$[ ]	$[ ]	$[ ]	UG TCNZRI
900	$[ ]	$[ ]	$[ ]	
600	$[ ]	$[ ]	$[ ]	
400	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI update, A TCRI
300	$[ ]	$[ ]	$[ ]	
200	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI update, A TCRI
100	$[ ]	$[ ]	$[ ]	UG TCRI, B TCNZRI update, A TCRI
50	$[ ]	$[ ]	$[ ]	UG TCRI, B TCRI, A TCRI
25	$[ ]	$[ ]	$[ ]	
18	$[ ]	$[ ]	$[ ]	
12	$[ ]	$[ ]	$[ ]	
6	$[ ]	$[ ]	$[ ]	
1	$[ ]	$[ ]	$[ ]	

Feeder/Distribution Inputs

338. The feeder/distribution inputs, with descriptions are summarised below:

Table 17: Feeder / Distribution Inputs

Value	Variable Name	Comments
[ ]	max_drop_length	Kilofeet – maximum distance from CT to customer premises
0.5	user_lambda	Used to locate customer on lot, 1= centre, 0= edge
12	copper_gauge_xover	Kilofeet – decision point for use of 0.4mm or 0.63mm cable
22.3	max_copper_distance	Kilofeet – maximum reach for copper cable
1.25	MaxCopperPenalty	Cost penalty multiplier if copper cable in cluster exceeds length limit
12	copper_t1_xover	Kilofeet - unused
0	t1_fiber_xover	kilofeet; - Set this value to zero to turn off T1 technology for switched services
1.25	t1_redundancy_factor	- unused
24	copper_placement_depth	Inches – burial depth, has terrain factor dependencies if changed
36	fiber_placement_depth	Inches – burial depth, has terrain factor dependencies if changed
3	CriticalWaterDepth	Feet – unused, has terrain factor dependencies if changed
1.3	WaterFactor	Multiplier - unused
12	MinSlopeTrigger	Unused – has terrain factor dependencies if changed
1.10	MinSlopeFactor	Unused – has terrain factor dependencies if changed
30	MaxSlopeTrigger	Unused – has terrain factor dependencies if changed
1.05	MaxSlopeFactor	Unused – has terrain factor dependencies if changed
1.20	CombSlopeFactor	Unused – has terrain factor dependencies if changed
0%	pct_ds1	Percentage of business lines terminated on T1 – unused
0%	pct_lsa	Percentage of special access lines carried by DS1 or DS3 – unused
24	ChannelsPerT1System	unused
2	PairsPerT1System	unused
4	FibersPerTerminal	
2016	CapacityF2016	Capacities of Fibre terminals
1344	CapacityF1344	
672	CapacityF672	
96	CapacityF96	
60	CapacityF24	60 channel minimum unit
96	CapacityT96	
24	CapacityT24	
10	Lines_per_bus	For use with Census Block input information – unused
1.00	DistRoadFactor	Use rectilinear distances rather than road factor
1.00	FiberFillFactor	1 = 100%
1	DistanceType	1 = rectilinear, 2 = airline
1	FeederRoadFactor	Use rectilinear distances rather than road factor
1	Max_SAIs	Maximum number of cabinets placed in a cluster
0%	DefaultSpclAccessRatio	No special access lines costed
12	RepeaterSpacing (Kf)	For T1 feeder systems - unused
0	European indicator	Cable placing option for some European regulators: 0 = unused
500	European cutoff density	Unused

Fibre Cable

339. Costs in the tables below include material, placing, splicing and engineering. Fleeting costs are proportional to trenching difficulty factors and are included as averages within structure costs. Entries in black are direct data values supplied by parties. The source is noted in the Comments area of the Table. The input values are unchanged from the 2001/2002 determination, but modelled capital charges track the tilt value for Fibre Cable through use of ‘t = 5’ in the annualisation formula.

340. Where parties do not use a particular size of cable, the cost value (in **blue**) has been interpolated or extrapolated from supplied data. This approach is consistent with

parties' estimation of cable jointing/splicing costs and scales placement and engineering costs, particularly for the larger cable sizes.

Table 18: Fibre Cable Costs

Size	UG	Buried	Aerial	Comments
288	$[ ]	$[ ]	$[ ]	
144	$[ ]	$[ ]	$[ ]	
96	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCRI
72	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCRI
60	$[ ]	$[ ]	$[ ]	
48	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCNZRI
36	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCNZRI
24	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCNZRI
18	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCNZRI
12	$[ ]	$[ ]	$[ ]	UG TCNZRI, B TCNZRI, A TCNZRI
1	$[ ]	$[ ]	$[ ]	

T1 Feeder

341. The T1 feeder capability is not used.

Plant Mix

342. The relative proportions of aerial, buried and underground plant vary by density zone according to the following tables. The entries represent minimum placement percentages for underground, buried and aerial respectively. When they sum to less than 100%, HCPM selects the residual placement to minimise cost for the particular terrain type and density.

343. Percentages of buried infrastructure are maintained above 0% to take account of sharing with the core network and areas in which aerial is not practical. Telecom inputs have been selected for densities greater than 650 as these are more likely to reflect requirements for serving a mix of higher density residential and business areas.

Table 19: Distribution Plant Mix

Density	UG	Buried	Aerial	Comments
0	0.00%	30.00%	0.00%	Minimum placement percentages
5	0.00%	30.00%	0.00%	
100	0.00%	30.00%	0.00%	
200	0.00%	30.00%	2.00%	
650	0.00%	30.00%	2.00%	
850	10.00%	88.00%	2.00%	Force Buried/UG in suburban and more
2550	27.00%	72.00%	1.00%	dense areas, based on TNZ values
5000	27.00%	72.00%	1.00%	
10000	40.00%	59.00%	1.00%	

Table 20: Copper Feeder Plant Mix

Density	UG	Buried	Aerial	Comments
0	0.00%	30.00%	0.00%	Minimum placement percentages.
5	0.00%	30.00%	0.00%	
100	0.00%	50.00%	0.00%	
200	0.00%	50.00%	0.00%	
650	0.00%	50.00%	0.00%	
850	60.00%	40.00%	0.00%	
2550	75.00%	25.00%	0.00%	
5000	90.00%	10.00%	0.00%	
10000	95.00%	5.00%	0.00%	NZ

Table 21: Fibre Feeder Plant Mix

Density	UG	Buried	Aerial	Comments
0	0.00%	30.00%	0.00%	Minimum placement percentages.
5	0.00%	30.00%	0.00%	
100	0.00%	50.00%	0.00%	
200	0.00%	50.00%	0.00%	
650	0.00%	50.00%	0.00%	
850	60.00%	40.00%	0.00%	
2550	75.00%	25.00%	0.00%	
5000	90.00%	10.00%	0.00%	
10000	95.00%	5.00%	0.00%	NZ

Drop Terminal

344. Drop Terminals are equivalent to Cable Terminals (CTs) in Telecom's network. The costs include the terminal hardware, the cable tail, which connects into the distribution cable, jointing into the distribution cable and termination of the tail into the terminal.

345. Telecom and TelstraClear continue to provide widely differing costs for Drop Terminals. TelstraClear suggest that Telecom costs are higher than those experienced in a mass network rollout as they 'indicate rollout on a casual terminal-by-terminal basis'.

Table 22: Cost Estimates for Buried Drop Terminals

Buried	**5 pair**	**10 pair**	**15 pair**	**Remark**
Terminal	$160	$180	$330	'Quiet Front' Terminal
Tail	$45	$45	$45	Assume 15m @ $3/m
Joint to main	$205	$205	$205	See Joint table below
Terminate	$50	$50	$50	
Total	**$460**	**$480**	**$630**	

Table 23: Combination Cost Estimates of Drop Terminals

Joint Table	**Cost**	**Remark**
Dig and Back Fill	$75	2 hours inc travel
Joint	$50	
Materials	$80	

Table 24: Cost Estimates for Aerial Drop Terminals

Aerial	**5 pair**	**10 pair**	**15 pair**	**Remark**
Terminal	$160	$180	$330	'Quiet Front' Terminal
Tail	$10	$10	$10	
Joint to main	$130	$130	$130	
Terminate	$50	$50	$50	
Total	**$350**	**$370**	**$520**	

346. Note that costings have been made using a 'Quiet Front' terminal which is consistent with reduction of total life time costs for Drop Terminals. Drop terminal costs provided by the Commission are entered in red in the following table. Cost values provided by parties are entered in black and extrapolated values beyond the ranges provided are entered in blue.

347. For terminal sizes larger than 25 the values in this table reflect the cost of an indoor termination frame. The extrapolated costs are based on Telecom 400 pair frame costs. TelstraClear values provided for indoor frames do not appear to account for full installation costs.

348. The input values are unchanged from the 2001/2002 TSO Determination, but modelled capital charges track the tilt value for Drop Terminals through use of 't = 5' in the annualisation formula.

Table 25: Drop Terminal Costs

Size	Buried	Aerial	UG	Comments
1	$[ ]	$[ ]	$[ ]	UG – TCNZRI
6	$[ ]	$[ ]	$[ ]	UG – TCNZRI
12	$[ ]	$[ ]	$[ ]	UG – TCNZRI
25	$[ ]	$[ ]	$[ ]	A-TCNZRI
50	$[ ]	$[ ]	$[ ]	TCNZRI
100	$[ ]	$[ ]	$[ ]	
200	$[ ]	$[ ]	$[ ]	
400	$[ ]	$[ ]	$[ ]	UG – TCNZRI
600	$[ ]	$[ ]	$[ ]	
900	$[ ]	$[ ]	$[ ]	
1200	$[ ]	$[ ]	$[ ]	
1800	$[ ]	$[ ]	$[ ]	
2400	$[ ]	$[ ]	$[ ]	
3600	$[ ]	$[ ]	$[ ]	
5400	$[ ]	$[ ]	$[ ]	
7200	$[ ]	$[ ]	$[ ]	NZ

FDI – Feeder cabinet costs

349. Outdoor cabinet costs are based on Telecom 400 and 1400 port cabinets. The costings are fully installed. Note that HCPM determines costs for cabinets with greater than 7200 lines by summing the input values for two or more cabinets with less than 7200 lines.

350. The input values are unchanged from the 2001/2002 determination, but modelled capital charges track the tilt value for FDI through use of ‘t = 5’ in the annualisation formula.

351. See Drop Terminal costing above for indoor cost analysis.

Table 26: Feeder Distribution Interface Costs

Lines	Outdoor	Indoor	Comments
1	$[ ]	$[ ]	Costs of Outdoor and Indoor feeder/distribution
50	$[ ]	$[ ]	interface devices
100	$[ ]	$[ ]	
200	$[ ]	$[ ]	
400	$[ ]	$[ ]	Outdoor, TNZ 400 port cabinet
600	$[ ]	$[ ]	Outdoor, TNZ 1400 universal cab (fully costed)
900	$[ ]	$[ ]	
1200	$[ ]	$[ ]	
1800	$[ ]	$[ ]	
2400	$[ ]	$[ ]	
3600	$[ ]	$[ ]	Costs for SAIs with greater than 7200 lines
5400	$[ ]	$[ ]	are determined by summing the input values
7200	$[ ]	$[ ]	for two or more SAIs with less than 7200 lines
9000	$[ ]	$[ ]	
10800	$[ ]	$[ ]	
12600	$[ ]	$[ ]	
14400	$[ ]	$[ ]	
16200	$[ ]	$[ ]	
18000	$[ ]	$[ ]	
19800	$[ ]	$[ ]	
21600	$[ ]	$[ ]	
23400	$[ ]	$[ ]	
25200	$[ ]	$[ ]	
27000	$[ ]	$[ ]	
28800	$[ ]	$[ ]	NZ Cabinets and building frames

Fill Factors

352. Fill factors are commonly quoted in the context of design rules for initial network installation, typical utilisation or the trigger point at which relief is required. Fill Factor is defined as:

Fill Factor = (demand + intact lines + faulty lines)/total capacity

353. The Commission has adjusted the factors for rural areas to 60% for Feeder Cable and 40% for Distribution Cable. Although this may be common practice, modelling in HCPM creates unrealistic costs on low density feeder routes by provisioning up-front all of the systems and electronics (line cards) to meet the demand growth being allowed for. This aspect of the HCPM model may be adjusted in future versions, but for the purposes of this determination, rural feeder fill factor is re-adjusted to 80% to correct for over provisioning.

Table 27: Fill Factors

Density	Feeder	Distr	Comments
0	80.0%	40.0%	Utilization factors for feeder and distribution plant
5	80.0%	40.0%	These are for copper
100	80.0%	40.0%	
200	80.0%	40.0%	
650	80.0%	60.0%	
850	80.0%	60.0%	
2550	80.0%	60.0%	
5000	80.0%	60.0%	
10000	80.0%	60.0%	NZ

Structure Costs

354. Outside Plant 'Structure' in HCPM refers to the set of facilities that support, house, guide or otherwise protect distribution and feeder plant as follows:

- Aerial, which includes telephone poles and associated hardware such as anchors and guys
- Buried, which consists of trenches
- Underground, which includes trenches, conduit and manholes

355. Structure costs include the initial capital outlay for physical material associated with outside plant structure (including trenches, poles etc); the capitalised costs for supplies, delivery, provisioning, right of way, resource consent and any other capitalised cost directly attributable to these assets; and the capitalised cost for the labour, engineering and materials required to install the materials. For example, buried and underground structures include costs for capitalised labour, engineering and material costs for activities such as ploughing, trenching, backfilling, boring, concrete/asphalt cutting etc.

356. Structure costs are dependent on area type, defined within HCPM in terms of line density. Table 28: Areas by Line Density defines the areas by line density:

Table 28: Areas by Line Density

Area Type	Density in line/square mile	Density in line/km^2
Rural	0	0
Rural	5	2
Rural	100	39
Rural	200	78
Suburban	650	254
Suburban	850	332
Urban	2550	996
Urban	5000	1953
Metro	10000	3906

357. The specific HCPM structure input tables follow:

Table 29: Normal / Easy Terrain Costs

	Normal Terrain Costs $/ft						
	Underground		Buried		Aerial		
Density	**Feeder**	**Distr.**	**Feeder**	**Distr.**	**Feeder**	**Distr.**	**Comments**
0	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	Placement costs for easy terrain
5	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
100	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
200	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
650	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
850	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
2550	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
5000	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
10000	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	NZ

358. In the case of Normal terrain, 'medium' rural trench rates have been adopted for the underground category, recognising the likely trenching techniques required.

Table 30: Soft Rock / Medium Terrain Costs

	Soft Rock Costs $/ft						
	Underground		Buried		Aerial		
Density	**Feeder**	**Distr.**	**Feeder**	**Distr.**	**Feeder**	**Distr.**	**Comments**
0	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	Placement costs for medium terrain
5	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
100	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
200	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
650	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
850	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
2550	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
5000	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
10000	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	NZ

Table 31: Hard Rock / Hard and Rock Terrain Costs

	Hard Rock Costs $/ft						
	Underground		Buried		Aerial		
Density	**Feeder**	**Distr.**	**Feeder**	**Distr.**	**Feeder**	**Distr.**	**Comments**
0	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	Placement costs for hard terrain
5	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
100	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
200	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
650	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
850	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
2550	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
5000	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	
10000	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	NZ

Manhole Costs

359. The following costs are Commission estimates based on weighted averages of Telecom's contractor data. Hard Rock information is an average of weighted averages (by cable pair kilometres) of installation and material costs from CBD and concrete/high traffic areas. Similarly, Soft rock is derived from sealed road/medium traffic areas and Normal from suburban/grass berm.

360. The input values are unchanged from the 2001/2002 TSO Determination, but modelled capital charges track the tilt value for Manholes through use of 't = 5' in the annualisation formula

Table 32: Manhole Costs

Duct Capacity	Normal	Soft Rock	Hard Rock	Comments
2	$[ ]	$[ ]	$[ ]	Installed Cost for Manholes
4	$[ ]	$[ ]	$[ ]	
9	$[ ]	$[ ]	$[ ]	
99	$[ ]	$[ ]	$[ ]	NZ

Manhole Spacing

361. Manhole spacing is based on Telecom supplied data.

Table 33: Manhole Spacing

Density	Spacing(ft)	Comments
0	[ ]	
5	[ ]	
100	[ ]	
200	[ ]	
650	[ ]	
850	[ ]	
2550	[ ]	
5000	[ ]	
10000	[ ]	

Infrastructure Sharing

Table 34: Infrastructure Sharing

Density	Buried	UG	Aerial	Comments
0	100.00%	100.00%	100.00%	Percentage of underground, buried and aerial structure used by telco
5	100.00%	100.00%	100.00%	i.e. 100% means fully owned by telco, 50% means half shared with
100	100.00%	100.00%	100.00%	other utility/telco
200	100.00%	100.00%	50.00%	
650	100.00%	100.00%	50.00%	
850	100.00%	70.00%	50.00%	
2550	100.00%	70.00%	50.00%	
5000	100.00%	70.00%	50.00%	
10000	100.00%	55.00%	35.00%	NZ

Fibre Distribution and Miscellaneous Constants

362. HCPM utilises American sizing for fibre distribution systems. Telecom have provided costs for some systems up to 360 lines. It is necessary at this time to

extrapolate these figures to estimate costs for larger systems. The smallest system has been reset to 60 channels to correspond to Telecom's 8Mb/s PDH cabinet – see fibre systems capacity in Feeder/Distribution inputs sheet.

Table 35: Fibre Distribution and Miscellaneous Constants

Value	Variable	Comments
$[ ]	cost_per_drop_kf	Units are in kilofeet
$[ ]	nid_cost	[ ]
$[ ]	duct_cost_per_kf	Units are in kilofeet
$[ ]	a2016	Fixed cost of size 2016 fibre terminal
$[ ]	b2016	Variable cost of size 2016 fibre terminal
$[ ]	a1344	
$[ ]	b1344	
$[ ]	a672	
$[ ]	b672	
$[ ]	a96	
$[ ]	b96	
$[ ]	a24	60 channel system minimum
$[ ]	b24	
$[ ]	ac96	Fixed cost of size 96 T1 (or HDSL) terminal
$[ ]	bc96	Variable cost of size 96 T1 (or HDSL) terminal
$[ ]	ac24	T1 is unused
$[ ]	bc24	
$[ ]	site_prep_cost	Telecom
$[ ]	Fiber_splice_cost	NZ

Financial Inputs

363. The input values are unchanged from the 2001/2002 TSO Determination. However, adoption of 12% of capital cost as a means of accounting for direct operating and maintenance costs will scale resulting capital charge factors by 1.12.

364. The original price tilt information supplied by Telecom was real and has been treated as nominal. This is discussed in the text following paragraph 378. The corrected price tilts are shown under 'Nominal price tilt'.

Table 36: HCPM Model Technologies Asset Economic Profile Information

Category	Asset life	Real Price tilt	Time to Build	Nominal price tilt
ac_ugd_cop	[ ]	[ ]	0.5	[ ]
ac_bur_cop	[ ]	[ ]	0.5	[ ]
ac_aer_cop	[ ]	[ ]	0.5	[ ]
ac_ugd_fib	[ ]	[ ]	0.5	[ ]
ac_bur_fib	[ ]	[ ]	0.5	[ ]
ac_aer_fib	[ ]	[ ]	0.5	[ ]
ac_ugd_struc	[ ]	[ ]	0.5	[ ]
ac_bur_struc	[ ]	[ ]	0.5	[ ]
ac_aer_struc	[ ]	[ ]	0.5	[ ]
ac_manhole	[ ]	[ ]	0.5	[ ]
ac_t1_term	[ ]	[ ]	0.5	[ ]
ac_fib_term	[ ]	[ ]	0.5	[ ]
ac_fdi	[ ]	[ ]	0.5	[ ]
ac_fib_splice	[ ]	[ ]	0.5	[ ]
ac_drop	[ ]	[ ]	0.5	[ ]
ac_drop_term	[ ]	[ ]	0.5	[ ]
ac_nid	[ ]	[ ]	0.5	[ ]
ac_repeater	[ ]	[ ]	0.5	[ ]

Xtra and Telecom Mobile WACC

365. The Commission has used a WACC of 14% for Telecom Xtra and 10.5% for Telecom Mobile.

Financial Considerations

366. When asset prices are declining, the tilted annuity approach to calculation of annual charge factors adopted by the Commission for TSO modelling creates a declining profile of nominal annual capital charges as the year 't' is advanced in the formula (as expressed in the TSO Implementation Paper):

Equation 7: Tilted Annuity

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

Where:

r	=	the rate of return on capital
α	=	the nominal rate of change of the optimised replacement cost of the asset
t	=	a particular year in the economic life of the asset
N	=	the economic life of the asset
V	=	the optimised replacement cost of the asset.

367. The practical implementation of the formula in the HCPM, GQ-AAS and CostProNZ models also includes a factor to allow for time to build 'u':

Equation 8: Tilted Annuity Correction for Time to Build

$$((1+r)/(1+\alpha))^u$$

368. An issue is whether all model costs should be reviewed (re-optimised if there is new technology, or adjusted by their tilt) and t remains 1, or if there is no significant optimisation between periods, t progresses to 't = 5'.

369. The Commission considers that cost adjustments indicated by the parties for the TSO period do not constitute a radical re-optimisation of the network. For this reason, some small adjustments are made to improve modelling and t is progressed to 5 in both the CostProNZ model and the Commission's net cost calculation.[42]

370. The annualised cost of capital is given by Equation 9: Annualized Cost of Capital.

Equation 9: Annualized Cost of Capital

$$V\left(\frac{1+r}{1+\alpha}\right)^u \frac{(1+\alpha)^{t-1} * (r-\alpha)}{1-\left(\frac{1+\alpha}{1+r}\right)^N}$$

371. Where:

α	=	the nominal rate of change of the optimised replacement cost of the asset
u	=	the time to build in years
r	=	the rate of return on capital
t	=	the particular year in the economic cost of the asset
N	=	the economic life of the asset
V	=	the optimised replacement cost of the asset

RMA Costs

372. The Resource Management Act ("RMA") is New Zealand's legislation that "promotes the sustainable management of natural and physical resources"[43]. Developments affecting the environment can be subject to cost increases due to the compliance costs associated with the RMA.

373. Any network deployment on as large a scale as the scenarios modelled by this TSO would incur considerable delays and costs. Delays would be part of the project planning for this undertaking. There would be 'unders' and 'overs' but it is expected that there would be no net cost due to delays. There would be direct compliance costs caused by the RMA. These costs would be difficult to separate and to identify as belonging to a particular site. Most of the costs would be common as part of a nationwide pool of these costs. As such they are not TSO costs.

Operating Costs

374. For the purposes of this determination, the Commission has adopted the following operating cost factors:

    a. $[ ] TCNZRI per line per annum service cost for residential lines
    b. $[ ] TCNZRI per line per annum service cost for business lines

[42] Note that period 2 applies only to fixed network assets which are common with those modelled in the previous TSO period. The separate wireless local loop spreadsheet model assumes year 1 in annualising the costs of this new radio equipment.

[43] Section 5 of the Resource Management Act 1991.

c. 12% of capital cost per annum for direct network operating and maintenance costs

Line Rental Cap

375. Telecom has raised its residential rental prices to recover the CPI movement. Accordingly, the Commission has used actual standard (undiscounted) Telecom line rentals rather than CPI based maximums in this determination.

Modelling Imputation

376. OPA (Opito Bay) has no revenue recorded against its [ ] TCNZRI business and residential lines. The Commission has imputed the revenue by using the revenue from the 2003/2004 period.

Processing of Revenue Data

377. In response to TelstraClear's request for greater transparency in the conversion of Telecom revenue data to average per line revenues for each ESA, the following files have been generated and are used as input's to the Commission's net cost calculation tool (contained in subdirectories under 'c:\hcpm\TSO\wk_lib\').

File	Description
grossrevs.csv	Contains average revenue per line calculated directly from Telecom's figures provided in the files of the form 'ccmathsq#_ESAs.xls'. The revenue figures for each ESA are based on standard line rental (for the particular quarter) plus average supplementary revenue per line net of Vodafone fixed to mobile and other interconnect costs. The 4 quarterly averages are added to form an annual figure (quarterly approach required to account for changing effective ESA line counts). The Commission has scaled up the resultant average revenues in line with the additional unallocated revenues identified by Telecom.
mobilevols.csv	Contains the average per line fixed to Telecom Mobile traffic volume for each ESA (seconds/line). Per minute TSO fixed to mobile termination costs are determined by Telecom's modelling at $[ ] TCNZRI per minute (10.5% WACC). This figure forms the default input to 7.01.01 of the Commission's net cost calculation tool, and can be changed as a variable on the tool's input screen. ESA per line fixed to mobile costs are deducted from gross revenues during the calculation of annual charge factors process.
incomingvols.csv	Contains average ESA per line incoming local and national call volumes. Incoming call costs for each call type are calculated by CostProNZ (CPNZ) and retrieved from the CPNZ scenario database by the net cost calculation tool. Calculated costs are deducted from gross average revenues for each ESA (which include incoming local and national call revenues).

File	Description
revbyline.csv	The file of average net revenues per line by ESA (used in the net cost calculation tool) is now created and placed in the sub directories under 'C:\HCPM\TSO\wk_lib' directory each time annual charge factors are changed in the net cost calculation tool. Specifically, revenue figures are calculated by netting calculated mobile and incoming traffic costs. In addition, revbyline.csv now holds average per line calling costs for each ESA. This is a change from previous versions of the net cost calculation tool which used average calling costs by area density type. Calling costs are automatically updated from the CPNZ scenario database when annual charge factors are changed.
esacosts.csv	This file is unchanged from previous versions of the net cost calculation tool, except that the direct cost associated with each ESA is automatically updated from the CPNZ database each time the annual charge factors are changed.
wcap.csv	New file which holds the information used to calculate the Wireless Technology Cost Cap when annual charge factors are changed in the net cost calculation tool
esamapping.csv	Mapping of ESA names for interworking of various Telecom and Commission adopted lists of ESAs. Note that 'grossrevs.csv', 'mobilevols.csv' and 'incomingvols.csv' use a Telecom ESA listing as they are derived directly from the Telecom revenue information.

Tilt Adjustment

378. The tilt represents an estimate of the rate of change of the replacement cost of capital equipment. In the first TSO determination, the Commission adopted tilts based on information submitted by Telecom.[44] The TSO and CostProNZ models produce results which are expressed in nominal terms.

379. The Commission has adjusted the tilts using the inflation rate of 2.6% originally used by Telecom by adding inflation to the tilts supplied by Telecom in the first TSO determination. The tilts were adjusted using the following formula:

Nominal Tilt% = (1+ real tilt %) (1 + inflation %)-1.
The tilts once adjusted do not have to be adjusted for subsequent determinations.

Net Cost Calculation Tool

380. The 'Net Cost Calculation' tool has undergone a few minor changes. The control panel has charged from the layout shown in 'Figure 6: TSO Main Control Screen v6.' to 'Figure 7: TSO Main Control Screen 7.01.01'. The binaries are internally identified by version numbers 4.0.0.2 and 7.01.01 respectively.

[44] Cf. Commerce Commission, *Determination for TSO Instrument for Local Residential Service for Period between 20 December 2001 and 30 June 2002*, 17 December 2003, para 125-6.

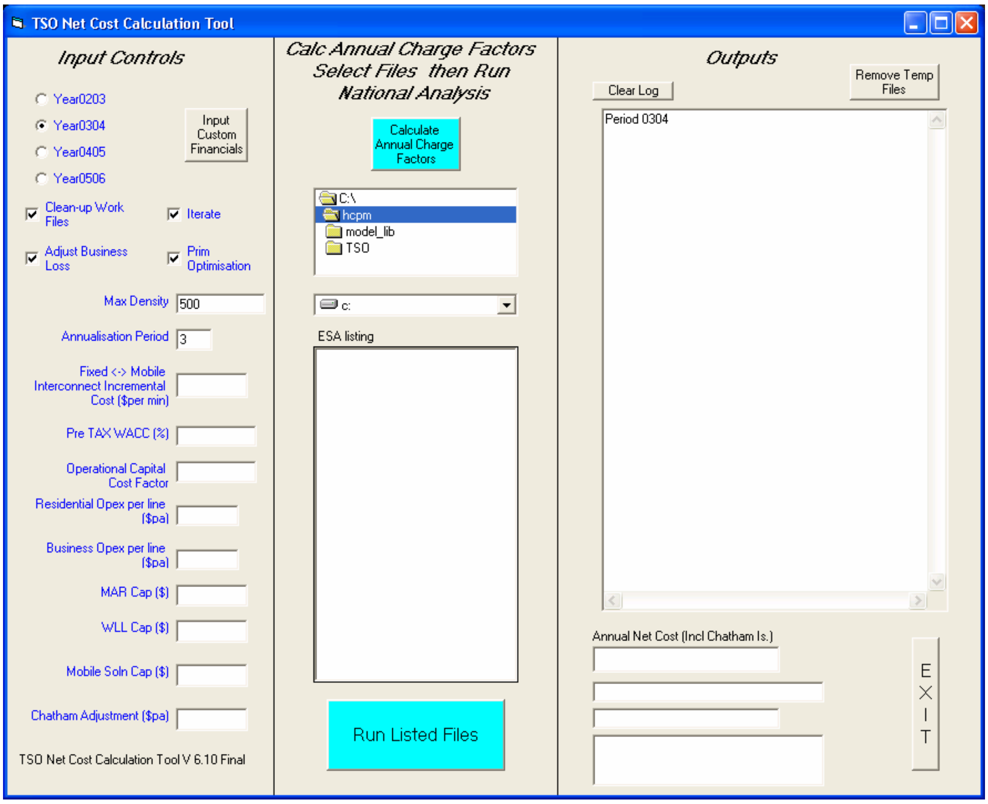

Figure 6: TSO Main Control Screen v6.10 Final

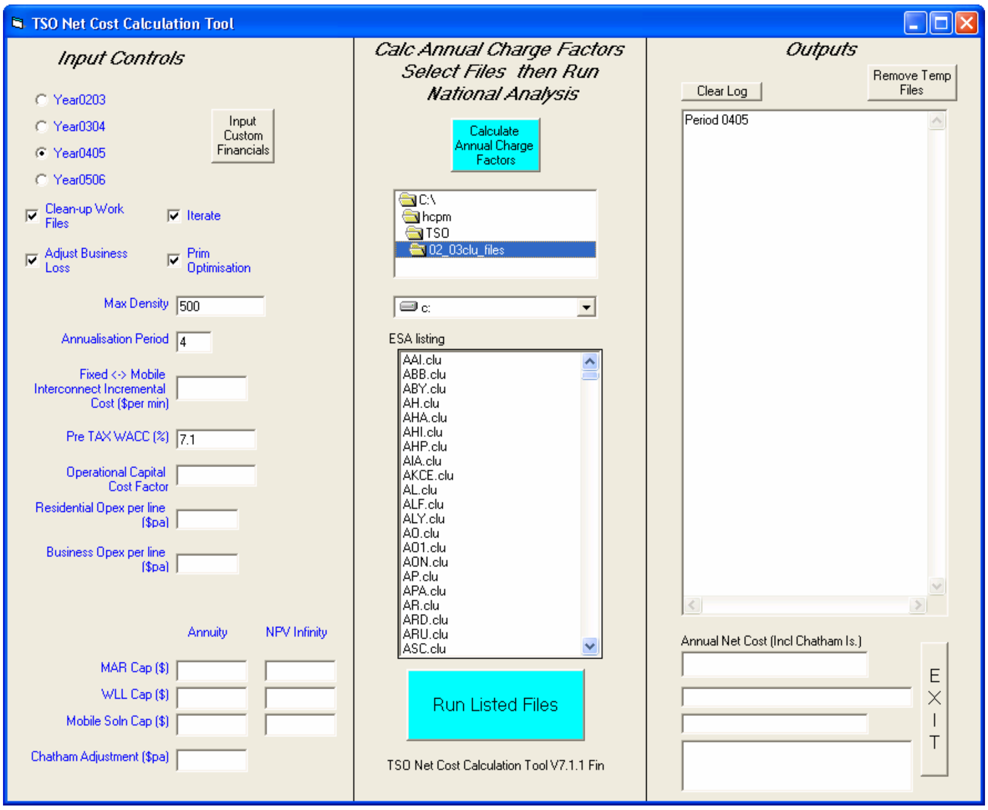

Figure 7: TSO Main Control Screen 7.01.01

381. The only substantive change from the 2003/2004 final determination is that the model now optimises to reduce the network NPV (previously it minimised the yearly cost of this capital).

382. Recent changes to the control panel:

- THE NPV associated with an ongoing investment in radio caps is entered on the front panel along with the equivalent annuity.

383. Changes to the underlying data structures and associated programs:

- The contents of 'annchg.txt' have changed as has been described in para 288.
- An additional set of coefficients has been provided n 'convert_to_ann.txt' for the conversion of NPV quantities reported in 'expense.csv' to annuity this is described in para 294.

Installer Instructions

384. The Commission has updated the TSO and the CostProNZ models. The install procedure has changed; the calculation tool has been restyled; the revenue data and traffic data have been updated.

385. The install procedure has changed – the instructions are located on the install disk in the file 'READ_ME_install_instructions.doc'. It is advisable to read these instructions before installing the applications and data.

386. The program suite comprising the TSO programme and the FCC HCPM program has been extensively operationally tested in Microsoft Windows XP and Office 2003. It has not been tested for Windows Vista. It is known that the CostProNZ program does <u>not</u> work with Excel 2007.

Multiple CostProNZ Tables and Associated Scenario Information

387. There are 3 sets of active scenario information they can be directly accessed via the CostProNZ application or they can be physically accessed under the directories HCPM, HCPM0304v22, HCPM0405v22 and HCPM0506v22 located in 'c:\program files\CostProNZ\Scenarios'.

388. The multiple scenarios relating to different years files need support from multiple '.ini' files. These file have moved from ' c:\program files\CostProNZ ' and are currently located in ' c:\program files\CostProNZ\ini_lib'.

Multiple HCPM Directories

389. Each year being modelled needs information related to the per customer revenue for that year. This information is held in 'c:\hcpm\TSO\wk_lib'. It is held in the four subdirectories HCPM, HCPM0304, HCPM0405 and HCPM0506. The files were originally held in 'c:\hcpm\TSO\work'. These files are important because not only do they provide the inputs to the TSO program but they also record averaged traffic costs from the CostProNZ program they record the 'decision log' (national.csv) for the TSO program and as part of that log they record the TSO loss. This loss is recorded at a cluster level. This functionality is no different from the previous version's functionality the files are positioned in a different location.

Updated data

Tilted data

390. Telecom has provided real tilts, the process to change them to nominal tilts is discussed on paragraph 378. Nominal tilts have been used.

TSO Model Inputs

391. The TSO application has hard coded presets set in module 'form_load()' in the TSO applications VB source code but they can be temporally overwritten via the front panel controls the current settings are:

Table 37: TSO Model Preset Inputs

Field	Static	Set yearly	2005/2006
Annualisation period		X	5
Fixed to mobile incremental cost ($permin)		X	[ ] TCNZRI
Operational Capital cost factor	X	X	1.12
Pre Tax WACC		X	7.4
Residential opex per line	X		$[ ] TCNZRI
Business opex per line	X		$[ ] TCNZRI
MARCap (opex.npv)		X	$[ ], $[ ]
WLLCap (opex.npv)		X	$[ ], $[ ]
Mobile Solution Cap (opex.npv)			$[ ], $[ ]
Chatham Island Correction		X	$762,896

HCPM Model Inputs

392. The directory 'C:\hcpm\TSO\wk_lib' has four directories HCPM, HCPM0304, HCPM0405, HCPM0506 corresponding 2002/2003 through 2005/2006 respectively. The files in these directories are:

Table 38: HCPM Yearly Input Files

	Static	Set yearly	created in first 1/2 of TSO	created in 2nd 1/2 of TSO	notes
defecondef. csv	X				this is the default economic constants. Tilt etc
econdef.csv					this is the economic constant, possibly after they have been modified by the pgms operator
esacost.csv			X		ESA cost information calculated by stage 1 of the modelling.
esamapping.csv	X				remap some of the names
esanames. csv	X				the link between the abbreviations and the actual names.
grossrev.csv		X			ESA revenues - this information is calculated at the beginning of the period and then left. It is calculated from information provided by Telecom. The field is made up. of the average revenue by customer type for each ESA.
incomingvols.csv		X			all the traffic volumes.
mobilevols.csv		X			mobile traffic volumes
national.csv				X	this is a log file on the TSO programs execution.
newterrain.csv	X				this is a new density scheme.
outtmpcnv.csv					
outtmpprofit.csv					
revbyline.csv			X		ESA information calculated at stage 1 -it includes revenue plus traffic costs.
wcap.csv	X	X			radio cap information
wll.csv	X	X			ESA when wireless local Loop will work.

393. The 'C:\hcpm directory' has 'V6_5 hcpm_current_inputs.xls' this is a series of excel tables that can be exported via a macro, this macro auto runs but can be triggered its tables include those listed in below in Table 39. Some of the tables are overwritten by the TSO model when it runs.

Table 39: HCPM Default Inputs

Table	Static	Set yearly	Set by TSO program	notes
24gdist.txt	X			24 gauge dist unit costs – aerial, buried, ducted
24gfdr.txt	X			24 gauge feeder costs– aerial, buried, ducted
26gdist.txt	X			26 gauge dist unit costs– aerial, buried, ducted

Table	Static	Set yearly	Set by TSO program	notes
26gfdr.txt	X			26 gauge feeder unit costs– aerial, buried, ducted
ANNCHG.txt			X TSO pgm tilts this info	Annual charge factors Capex-> Opex by technology class
CLUSTER.txt	X			Cluster info – set up
CuFDRMIX.txt	X			Copper feeder Mix of aerial, buried & ducted by density
DISTRMIX.txt	X			Distribution Mix of aerial, buried & ducted by density
DROP.txt	X			Drop Terminal costs – by size and deployment location
FDCOST.txt	X			Assorted feeder cost info
FDI.txt	X			Feeder distribution interface costs
FEEDDIST.prm	X			Feeddist info
FIBRCABL.txt	X			Fibre cable unit costs– aerial, buried, ducted
FiFDRMIX.txt	X			
FILLFACT.txt	X			Plant fill factors
HARDROCK.txt	X			Hard rock terrain costs by technology
INTRFACE.txt	X			Interface with cluster & interface software
MHCOST.txt	X			Manhole costs by duct sizes
MHSPACE.txt	X			Manhole spacing
NORMAL.txt	X			Normal terrain costs by technology
SHARING.txt	X			Plant sharing assumptions
SOFTROCK.txt	X			Soft rock terrain costs by technology
SOILTX.txt				Soil texture – NOT USED
T1fdr.txt	X			T1 Feeder costs – aerial, buried, ducted

Program Maintenance

394. The TSO program has been maintained so that common tasks, performed in different parts of the program suite, are performed by one piece of code. This has allowed improved focus on the functioning of the code and facilitates better documentation of the code but more importantly at a time when the code is being updated it results in easier maintenance by providing greater certainty that each instances of that code will also be updated.

395. The program has been updated by creating a ‘type’ definition. Any variable dealing with monetary quantities has been given the type NPV_1yr. This has included variables dealing with concepts such as “Profit”, “Cost”, and “Revenue”.

396. Competing technologies providing the same service with the lowest NPV are selected.

397. Any fiscal amount that was input as a yearly total e.g. the CostProNZ call costs or the fixed revenue was loaded both as a yearly amount and as the NPV of that amount.

Elimination of ‘exptot.csv’

398. The TSO program has previously made extensive use of ‘exptot.csv’ this is an output from the HCPM program suite. It is a summation of the total expenditure for an ESA. The expenditure reported prior to the code changes was in terms of an annuity. This annuity was used by the TSO program suite which operated to minimise the value of this annuity. The program updates required that both an annualised value and a NPV value could be read by the TSO program as the costs for a particular network configuration.

399. ‘Exptot.csv’ was unable to provide the required information. This information was available in ‘expense.csv’. The TSO program substituted use of ‘exptot.csv’ in favour of using ‘expense.csv’. The NPV is thus directly available and the annuity is able to be derived.

Regression Testing

400. Regression testing is that process whereby after a program has been updated that its functioning is tested against a previously known “good” standard.

401. Regression has been achieved from within the TSO program by the following process:

- The inputs used in 'annchg.txt' are set to the annuity weightings (the required changes are identified with 'regression_testing' in the comments field of the appropriate lines.
- The 'NPV' inputs for the various technology caps are set to their annualised values; and the NPV2Infinity function in the TSO program suite has to be modified as per the comments in the code. The effect of these modifications are to leave any ORC at the value of the ORC.

402. The program suite is run for TSO 2003/2004 and the system output, the 'national.csv' file, is compared with the 'national.csv' file as was used in the TSO Final Determination for 2003/2004.

Regression Testing Results

403. Regression testing was setup by overriding the inputs into the TSO model and by changing the code. The changes are identified in the TSO code by the comments "regression_testing". These changes involved changing the function that calculates the NPV2infinity so that it returns the ORC value. This function is used in numerous places to calculate the NPV of an amount. The HCPM annual charge factor is set to the annuity factor. The radio cap NPV factor presets are set to their equivalent annualised cost.

404. As part of the maintenance, many program variables that had taken on default types were defined. In one area it was realised that there was potential for numerical rounding errors so a preferred solutions was to use 'double' length variables. It is expected that this would result in minor changes to individual answers but no net change in the total TSO loss.

Analysis results

405. The analysis spreadsheet is included on the TSO distribution disk as 'national1.xls'

406. The following changes were observed (ideally no changes should have been observed):

- incremental cost has decreased by $76000 from a base of $[ ]M CCRI;
- income has increased by 6e-8;
- bus lines no change;
- res lines not change;
- Profit increased by $76000 from a base of $[ ]B CCRI;
- Clust Cost decreased by $7000 from a base of $[ ]M CCRI;
- Clust TSO Cost reduced by $6000 from a base of $[ ]M CCRI;
- Full ESA TSO Cost reduced by $220 from a base of $[ ]M CCRI;
- CostProNZ Direct Cost reduced by $17000 from a base of $[ ]M CCRI; and
- Hanging Costs reduced by $228 from a base of $[ ]M CCRI.

407. In total the TSO loss has increased by $46,000 from a base of $64M.

408. The two results are substantially the same. There were some instances where individual clusters had larger changes but these did not substantially effect the overall calculation. The Commission has taken the view that to this point the code changes had been correctly implemented.

APPENDIX 2: MAR RADIO CAP

409. Multi Access Radio ("MAR") also known as Customer Multi Access Radio ("CMAR") is a point-to-multipoint communications technology. From one central point it is able to service multiple locations. A communications channel is extended from a central location to a remote radio terminal. Service is then provided by cable from the remote radio terminal to remote customers.

410. Telecom has updated the cost used in the 2002/2003 Determination for rural MAR systems used to access customers in remote and rugged rural areas[45]. These costs are based on replacement of systems to service [ ] TCNZRI high cost customers in the Marlborough Sounds area using modern MAR systems.

411. TelstraClear argued that these MAR radio costs should apply only to extreme locations in New Zealand and that more cost effective radio solutions are available for general rural terrain. TelstraClear provided details of modelling which created a 4 step radio cost cap, utilising a mix of technologies for easy conditions through to extreme.

MAR Radio Cap Parameters

412. In the 2003/2004 TSO the Commission in response to submissions has revised the MAR cap design parameter related to the 'd-side' cabling.

413. The Commission has adopted the HCPM model as the basis for calculation, but has chosen to use the Prim algorithm for calculating the average structural distance per access lines. This distance is used to assess the average cabling distance per customer for MAR distribution cabling and the cost of this cabling. The training sample was those clusters that were MAR capped in the 2002/2003 TSO final determination.

414. The c++ code plus the output reports that the Commission used are held in the program suite under 'C:\hcpm\model_lib\prim'.

Commission Calculation of Prim Capital Costs

415. The Commission has modified the Prim code used in the TSO Revised Draft for 2003/2004. Two modifications described below have been made.

416. The Commission recognising that HCPM distances are rectilinear and that Prim distances are straight line as has allowed for a factor of 0.343 to be added to the Prim distance calculation. Each piece of cable sheath has its length increased by this factor. This factor has been experimentally determined so that in aggregate Prim distances are the same as HCPM distances.

417. Any individual cable sheath length over 2030m is restricted to this maximum length. The cost of this length of cable represents the incremental cost of providing a second MAR system. It is unnecessary then to model a greater single length of cable as an efficient design would simply deploy a second radio system.

418. The analysis determined that the average cable sheath distance between customers was [ ]m CCRI (this is equivalent to the [ ]m CCRI distance in the revised draft inflated by a factor or (1+0.343)). The optimised Prim distance allowing for the splitting of the clusters is 501m. The cost is then calculated using an average cost of $[ ]/m CCRI and allowing for a drop cost of [ ]TCNZRI at being [ ] CCRI.

[45] Commerce Commission, *Determination for TSO instrument for Local Residential Service for period between 1 July 2003 and 30 June 2003*, 24 March 2005, para 288

MAR Cost Drivers

Table 40: Updated MAR Cost Drivers

	CPI Equipment per Customer	Cabling per Customer	Site and RMA cost per Customer	Install, Power, Rigging per Customer
real tilt	[ ]%	[ ]%	[ ]%	[ ]%
nom tilt	[ ]%	[ ]	[ ]	[ ]
Time to Build (years)	0.5	0.5	0	0.5
Asset Life (years)	[ ]	[ ]	1000	[ ]
Equipment per Customer ($)	[ ] TCNZRI	[ ] CCRI	[ ] TCNZRI	[ ] TCNZRI
Operating cost penalty (radio over fixed)	[ ]			

(All entries TCNZRI unless otherwise indicated)

419. The fundamental cost drivers for each of the technologies have been used to calculate the tilted annuity plus the NPV∞ for that technology. There are presented on the following tables, the NPV and the annuity are entered into the TSO model.

Table 41: MAR Cost and Cost Drivers

2005/2006	Equipment per Customer	Cabling per Customer	Site and RMA cost per Customer	Install, Power, Rigging per Customer	Operating cost penalty (radio over fixed)
real tilt	[ ]%	[ ]%	[ ]%	[ ]%	
nom tilt	[ ]%	[ ]%	[ ]%	[ ]%	
Time to Build (years)	0.5	0.5	0	0.5	
Asset Life (years)	[ ]	[ ]	[ ]	[ ]	
Item CAPEX	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]
Annualised CAPEX	$[ ]	$[ ]	$[ ]	$[ ]	
Total Annualised CAPEX	$[ ]				
Capital Charge Factor	[ ]				
Total Cost	$[ ]	(cost inclusive of operating cost penalty)			
NPV Infinity CAPEX	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]
Total NPV Infinity CAPEX	$[ ]				
Capital Charge Factor	[ ]				
Total Cost NPV	$[ ]	(cost inclusive of operating cost penalty)			

(All entries TCNZRI unless otherwise indicated)

APPENDIX 3: WLL & MT RADIO CAPS

Gibson Quai-AAS Engagement

420. In response to submissions from TelstraClear and as part of the annual update of the TSO model to include appropriate, developed technologies, the Commission introduced Wireless Local Loop ("WLL") technology as a TSO access method for the 2002/2003 determination. This modelling was performed by Gibson Quai – AAS ("GQ-AAS"), based on the cost and performance of Airspan series 4000 radio systems and customer premises equipment. This technology is currently deployed by Kordia for radio DSL in some Project Probe regions and is one of the technologies identified by TelstraClear as appropriate for New Zealand. In addition to the WLL cap, a mobile technologies radio cap based on GSM technology has been considered for the 2005/2006 TSO determination.

421. The Commission engaged GQ-AAS to update the 2002/2003 radio model or develop a new model that satisfies the requirements of Part 3 of the Act. They were tasked with building a model that will result in an average cost of access using a radio access technology which can be compared with the wired cost of access in the same CNVC clusters as derived from the Commission's HCPM Model for the TSO Determination. The model and the selected technology will be applicable to New Zealand conditions.

Radio Caps

422. The Commission implemented a 'Wireless Technology Cost Cap' within the model used to inform the 2001/2002 TSO Determination. The model identified TSO areas where a multi-access radio (MAR) fixed radio solution would be more cost efficient. The 2002/2003 determination saw the introduction of a Wireless Local Loop (WLL) cap. This cap was applied to plains and rolling plains. The Commission has updated the radio cap material that appeared in the 2002/2003 determination. This update was based on advice received from GQ-AAS. This update included the introduction of a third radio cap based on the use of Mobile Technology ("MT"). The GQ report to the Commission is at Appendix 10: GQ-AAS Wireless cost Cap . This uses the GQ-AAS analysis to derive the WLL and MT caps.

423. An early position, fundamental to the TSO optimisation has been the Commission's decision to scorch the nodes.[46] (This refers to retaining the core network, the ESA boundaries and the local exchange but optimising and rebuilding the network within the ESA.)

Engineering Inputs

Core Network Costs

424. The Commission's model has ensured that all usage costs associated with the PSTN core network[47] shall be recovered over time by the TSP. Capping implies that the local access network internal to an ESA has been replaced with a radio access network. The costs are modelled on the basis that the mobile network's TRX are terminated directly to the local exchange. This has in effect treated Mobile Technology on the same basis as WLL and MAR. To do otherwise would have in part scorched the core network. Elements of mobile infrastructure such as the mobile

[46] Commerce Commission, *Determination for TSO Instrument for Local Residential Service for period between 20 December 2001 and 30 June 2002*, 17 December 2003, para 447

[47] The core network extends as far as to include the local switch

networks MSC are not costed as part of the cap. The Mobile Technologies cap is a virtual incremental build on the local switch.

Customer Base Used to Calculate per Customer Costs

425. Telecom's customer locations and associated traffic determine the network's topology and dimensioning. The copper based HCPM network topology is held in a stasis as at 20 December 2001 though the per customer traffic is kept updated to represent traffic levels in the TSO year. The Commission's approach to modelling is that the comparison should be on a "like-for-like" basis. Both the copper based HCPM network and the mobile network should be priced for the same (or similar) customer base. This would apply to customer numbers and to their traffic. This means that the radio cap is designed and costed for: (i) customer numbers from 2001 excluding cluster '1'; and (ii) traffic levels representative of the analysis period.

Taxation Basis of Radio Models

426. The GQ-AAS model should treat tax in a manner consistent with the other models, it uses a pre tax WACC.

Desktop vs. Real Life

427. A desktop design predicting radio propagation by its very nature involves approximations and simplifications. The design does not know about real world factors that are either not available to the designer or are transitory. These might include problems due to vehicle movements, rain fade, multipath signals, obstructions such as a barn or other building or even seasonal effects of vegetation. A design margin of [ ]dB CCRI has been used. This margin has been set to allow for various unknowns that may be encountered when deploying a desktop design. Practical experience may result in an adjustment either way of this margin.

Multipath Effects

428. Multipath effects refer to a radio signal travelling between a transmitter and receiver that is received by multiple paths. This is seen on television signals as ghosting – while it is 'workable' for an analogue television signal it is not 'workable' for a digital telephony signal. The multipath may be caused by say a truck moving in the vicinity of either the transmitter or receiver where the radio signal might bounce off the truck reaching the receiver from a secondary path. This can result in a short term signal loss. The same phenomena can happen from adjacent terrain such as a local hill though the effect's duration would be longer.

429. Ideally each customer location should "see" more than one transmitter so that it can dynamically switch over to another transmitter if the path to the primary transmitter dynamically fades. This is the normal operation of mobile telephony systems such as CDMA or GSM.

430. The Commission's modelling approach uses a model based on a design to deliver a service similar to what might be expected from a telephone connected to the network via copper which is generally considerably better than that provided by a GSM network. The desktop design relies on part on fixed mobiles being able "to see" more that one base site to minimise the impact of multipath reflections and hence improve the performance of the service.

New Zealand Costs

431. Where possible New Zealand sourced prices are used to inform the GQ-AAS radio modelling. In instances where the items may only be sourced internationally e.g. GSM equipment then Australian prices adjusted by an exchange rate have been used

432. The restricted information "RI" on the following table is owned by the indicated party.

Table 42: New Zealand Prices use by GQ-AAS' Modelling

Item	Commission
1. Hourly house wiring labour rate to install CPE wiring.	[ ] TCNZRI
2. Hourly rate for a skilled technician to install and test Mobile base radio equipment.	[ ] TTRI
3. Cost of a section of land of approximately 500 sq M on an elevated location in rural New Zealand. Assume site access is available.	[ ] VNZRI
4. The cost of supply and installation of a suitable freestanding radio equipment building including civil works, fences, connection to power and security in rural New Zealand.	[ ] TTRI
5. The cost of supply, install and commission of a 60m mast in rural New Zealand including related civil works (This includes supply to site, erect mast, provision of footing, the mast will be guyed with earth works and lightening protection).	[ ] TCNZRI
6. The cost of supply install and commission of a 90m mast in rural New Zealand including related civil works (This includes supply to site, erect mast, provision of footing, the mast will be guyed with earth works and lightening protection).	[ ]CCRI[48]
7. Purchase and supply to site 10m pole and materials plus labour and equipment to erect the pole.	[ ] VNZRI
8. Base New Site - the cost of site selection land and radio path survey activities. (this activity would perhaps involve an engineer, other engineering staff, and field strength site trials with a jack up mast).	[ ] VNZRI
9. Customer Premises Equipment (CPE) cost for a pole mounted antenna which will involve labour, low gain GSM or CDMA antenna, feeder and misc. materials.	[ ] TTRI
10. Customer Premises Equipment (CPE) cost for roof mounted antenna which will involve labour, low gain GSM or CDMA antenna, feeder and misc. materials.	[ ] TTRI
11 Estimate of site rentals in provincial/rural areas in 2003/2004	[ ] TCNZRI

[48] Parties have submitted on the price for the 60m pole and not for the 90m pole. The Commission has been advised by GQ-AAS that the 90m pole is twice the cost of the 60m pole.

Traffic Form Factor

433. The traffic form factor is the ratio between the total traffic in a period (e.g. a week) and the peak traffic. The form factor expressed in BH[49]/week is an important design consideration. A large form factor implies less variation in traffic patterns while a numerically low form factor implies more variation in the hourly traffic pattern. The traffic form factor is proportional to the switching plant utilisation with 24BH/day being equivalent to constant utilisation over a period.

434. The Commission's WLL & MT Radio caps have been priced using the a form factor of 72BH/week (this is the same setting as the CostProNZ model uses).

New Zealand Traffic

435. The radio caps have been dimensioned and priced based on the traffic levels used by the CostProNZ model. These traffic levels are based on observed traffic (minutes of use) for all the call types. The Commission recognises that the "real" behaviour of internet customers would be different from that reported in the data. Some customers experiencing the "slow" download speed would not have so much usage, others however would persevere and have a longer connect session.

Submission: Revised Basis for Radio Caps

436. Network Strategies has submitted that it was possible to provide service to CNVC customers on a considerably wider basis than the Commission currently models.[50] Telecom questioned the method by which the Commission determined that ESA's were suited to the use of radio caps.[51] The Commission approached Telecom and the liable parties for comment on an improved methodology to determine the ESA that are more suited to the application of radio caps.[52]

437. Telecom has submitted that they had concerns over the "selection of sample ESA's belonging to each technology type.[53]

438. Telecom submitted that:[54]

> The key problem with the Commission's approach is the lack of any discussion on the rationale for what has been done, and why it has taken a particular approach. This makes it difficult for the parties to respond in a manner that might be helpful to the Commission.
>
> Telecom has not commented on the selection of the 201 ESA and the selection of the sample that has been studied by GQ-AAS. Telecom would be happy to comment on them but would first seek the Commission's rationale for the approach used, and some indication it was looking for suggestions from the parties on an alternate approach.

439. Network Strategies has submitted that:[55]

> the Commission's determination does not appear to be robust … the Commission's list of ESAs and clusters with mobile coverage should be expanded to encompass what is observable in practice for realistic New Zealand mobile networks.

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[49] Busy Hour
[50] Network Strategies, *The Wireless Cap for TSO 2003-4*, 15 March 2006, pp21-22 exhibit 3.8 and 3.9
[51] Commerce Commission, *Radio Workshop Transcript* p34 Line 37
[52] Commerce Commission, *TSO Local Calling Radio Cap* 19th April
[53] Telecom, *Telecom New Zealand Submission on the Wireless cap Calculation in the TSO 03-04 Draft Determination*, 15 March 2006, para 64
[54] ibid, paragraph 59
[55] Network Strategies, *Response to Telecom's submission on the 03/04 Radio Cap*, section 4.1

Commission consulted – Telecom Submitted

440. The Commission has consulted with Telecom and the liable persons and received the following submission from Telecom:[56]

> The Commission has suggested three proposals, based on:
>
> 1) Ranking the ESAs in terms of their 'roughness';
>
> 2) working out the percentage of customers within line of sight ("LOS") of the highest point in the ESA; and
>
> 3) some amalgamation of the two.
>
> We consider all have merit and all have potential downsides.
>
> Proposal 1 has the potential problem identified by the Commission - that much of the roughness of an ESA may be in areas where there are no customers. Customers are typically located in relatively flat valleys which may be separated by uninhabited ridges. If one just took the areas where the customers are located, then one might assume these areas have the same characteristics and costs as flat plain areas. However customers still need to be linked back to the mobile switch and this is likely to be much more expensive in 'rough' areas. Further, surrounding ridges will adversely affect LOS. Hence we consider that it is more appropriate to calculate the roughness index on the basis of all of the ESA and not just squares that include customers.
>
> Proposal 2 has the potential problem that the highest point in an ESA may well not be the point that provides coverage of the greatest proportion. So, for example, Te Aroha township, tucked into the foothills of Mt Te Aroha, may well be hidden from a tower on Mt Te Aroha itself. In addition, as illustrated by GQ-AAS, many ESAs require more than one base station to provide adequate coverage and hence a single reference point may not be the most appropriate.
>
> Proposal 3 has been suggested by the Commission on the basis that the predictive power of the above two proposals may depend on an outside factor such as ESA size. We consider that it is difficult to decide in advance of the costings what the key determinants may be. Nor do we think it necessary. The cost modelling suggested by the Commission in proposal 4 suggests a model where ESA size and other factors affecting radio costs are explicitly accounted for. Given this, we do not think it appropriate or necessary to predetermine the results of this analysis here. If the Commission was of a mind to use both proposal 1 and proposal 2, rather than make a choice between them, it would be better that both these enter the regression model in Proposal 4 as independent variables, rather than engage in the somewhat arbitrary pre-selection suggested by Proposal 3.
>
> On balance Telecom would support Proposal 1 with the roughness index calculated on the basis of the whole of the ESA and not just squares where customers are located.

441. Network Strategies has submitted that:[57]

> We recommend that the Commission determine its wireless caps by applying the following principles:
>
> <u>"Flat" areas</u>
>
> Determine ESAs and clusters which are eligible for a predictable standard average mobile or WLL line cost through:
>
> - taking into account the coverage of existing GSM, CDMA and other (BCL) wireless network solutions
> - a modification of Proposal 1 to test the terrain only in the areas of an ESA which has TSO network coverage (i.e. abandon the use of the irrelevant ESA boundary data), such as the HCPM clusters. This test should be applied to ESAs outside existing mobile coverage to identify additional areas which qualify for "flat" costs.
>
> Perform independent radio and cost modelling of mobile and WLL solutions for representative "flat" areas to determine the average costs, taking into account the existence of current networks and base-station locations within mobile coverage (modification of Proposal 4). The outcome of

[56] Telecom, *TSO – Local Calling Radio Cap*, 3 May 2006 letter
[57] Network Strategies, *Submission on Commerce Commission Modelling Proposals*, 3 May 2006, pp 12-13

this modelling would be a mobile cap and a WLL cap and, based on our modelling to date, we expect that the mobile cost would be significantly lower than WLL, because, in general, all flat areas are already served by mobile networks.

<u>Hilly areas</u>

For areas which do not qualify as "flat", we recommend that the Commission develop exact WLL and GSM (or CDMA) models for a broad range of hilly sample areas. These areas should not be restricted to ESA boundaries but should be based on likely wireless coverage areas (see the sample coverage areas in Network Strategies' previous wireless cap submission).

As for flat areas, the coverage of existing GSM, CDMA and other (BCL) wireless network solutions should be taken into account. For areas outside of existing coverage the recommended process is:

- identify sample areas of similar physical characteristics. The number of categories will depend on the number the Commission considers necessary to cover all the terrain and population density types (we used two categories - pockets and spread areas - when considering areas outside of mobile coverage)
- categorise non "flat" ESAs according to types identified above
- model the cost per line in each area type, which should be relatively consistent, as we found with our selection of areas (with the exception of a single outlier).
- apply the most efficient modelled cost for an ESA type in place of the current MAR cap in the 03/04 TSO net cost model

Commission View: Basis for Radio Caps

442. The Commission accepts in principle that it should develop transparent selection criteria which uses teledensity and terrain roughness to inform the classification of ESA as being suited for one radio technology over another. Both these measures were constructed by using the inner area where the population were located. This development was discontinued once the submissions described in this appendix were received and the MT and WLL caps became more expensive than the MAR cap. This relativity essentially rendered the cap inoperative.

443. GQ-AAS the Commission's consultant has advised that CDMA is the preferred technology post the 2003/2004 period. The effect is relatively small and has not been modelled. The traffic used in the 2004/2004 model is the same as that used in the 2005/2006 model i.e. it was not updated. This was not updated because traffic levels were similar and since a significant portion of the costs are not traffic dependent the Commission too the view that the cap prices would not change significantly to a point where they became active.

444. GSM is a Time Division Multiplex ("TDM") technology. Each conversation is granted access to the common channel bandwidth for a pre-allocated duration. There is a rapid exchange of information, the channel is relinquished and another unit is able to use the channel. The customer's transmitter then waits for their turn to send more of the conversation. This process happens so quickly as to be invisible to the customer. The time slots form a scarce resource. There are three mechanisms by which modem traffic can be carried : Circuit Switched Data ("CSD"), High Speed Circuit Switched Data ("HSCSD") and General Packet Radio Service ("GPRS"). Each method relies on gaining access to an appropriate number of time slots.

GSM Time Slots

445. Radio services provided over GSM using CSD may have a high initial connect speed that will meet or exceed the TSO deed requirement. The communications channel is inherently less stable and more prone to noise than a copper based PSTN circuit. This

may result in a customer modem retraining to a lower speed i.e. one that does not meet the TSO Deed.

446. The GPRS service provides a user experience that is closest to that of copper. It provides the nearest equivalent service in sustaining a modem data call's throughput. This service requires two time slots. The Commission has directed GQ-AAS to use two time slots in their modelling of internet modem traffic.

CPE Costs

447. The Commission's view is that conventional telephone instrument costs and any conventional customer premises cabling costs should be excluded from the radio cap models.

Submission: GQ-AAS Radio Models are Over Engineered

448. TelstraClear has submitted that the Commission should:

> reject Gibson Quai-AAS's radio cap models as they are based on over-engineered network designs relative to the requirements of the TSO deed and therefore do not meet the efficient service provider requirement.[58]

Commission View: GQ-AAS Radio Models are Over Engineered

449. To be over engineered an authoritative counterfactual model would have to be provided. The proposals seen to date do not provide comfort that the GQ-AAS models are over engineered. The major inputs provided in the form of submissions to the Commission involve the use of costs that are apparently not available to the TSP or reduced numbers of TRX that do not provide the required level of coverage to the customer locations. The Commission is not satisfied that the number of sites has been over engineered.

450. TRX antenna in the GQ-AAS design are set at a height that ensures that they are clear of surrounding vegetation or other geographical clutter which could otherwise adversely affect the stations signal quality.

451. GQ-AAS has been instructed by the Commission to review the need for 60m high masts. The Commission has been advised that this height mast has been selected to provide comfort that the antenna location will be clear of foreground clutter and vegetation.

452. The Commission has considered that:

- 90% of well defined terrain data points have a vertical accuracy of ± 5m and a horizontal accuracy of ± 22m ;[59]
- Plantation height varies with age and site quality. Plantations can reach typical heights of 40-50m, occasionally up to 60m;[60] and
- the MED 'Prism' database[61] of radio licences reports on transmitter heights it has indicated the following that only 2.8% of heights are above 50m.

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[58] TelstraClear, *Submission on Revised Draft Determination for TSO Instrument for Local Residential Service for period between 1 July 2003 and 30 June 2004*, 14 December 2006, p14
[59] Land Information New Zealand, *NZTopo Data Dictionary*, Version 3.5 page 6
[60] Bruce Manley, Associate Professor, Head of School , NZ School of Forestry, College of Engineering, Canterbury University
[61] http://www.rsm.govt.nz/publications/software/prism.zip

Table 43: Distribution of Prism heights for VNZ & TNZ Antenna Heights

Height	*Percentage*		*Height*	*Cumulative Percentage*
0	0.00%		<=0	0.00%
0-10	51.61%		<=10	51.61%
10-20	32.40%		<= 20	84.01%
20-30	8.47%		<= 30	92.49%
30-40	3.23%		<= 40	95.71%
40-50	1.51%		<= 50	97.22%
50-60	0.45%		<= 60	97.67%
>70	0.14%		<= 70	97.82%
More	2.18%			100.00%

453. The Commission notes that vegetation can grow up to 60 metres. It considers that minimum allowance has to be made for terrain information and that it is unlikely that in every case a height of 60m is needed to clear foreground clutter and vegetation especially given the tendency of telecommunication companies to locate their TRX on elevated portions of land. The experience of VNZ and TNZ in providing this radio service reflects the commercial drivers that they face in providing mobile service. Factors such as frequency reuse may dominate and result in a need to use lower towers. A position which said that all towers were 60m would ignore a reality that these towers may not always be required. The Commission has instructed GQ-AAS to use a maximum height of 30m in their modelling unless there are known contra indications.

454. NSL have submitted that the cost of a 30m pole is $[ ]VNZRI mast cost plus $[ ]VNZRI civil works.[62] The total cost is $[ ]VNZRI.

Submission: Line of Sight

455. Network Strategies has submitted that:

> Commission claims that line of sight is necessary because 'longer paths or obstructed paths results in signal loss which results in a lower probability that a signal path will be viable.'[63]
>
> If circuit availability is not sufficient then the link budget needs to be increased to compensate for the higher attenuation and/or allow higher levels of fade. This can be achieved in a number of ways:[64]
>
> • increase the base station antenna height, to allow a better signal path (this is expensive)
>
> • increase the transmission power (our design already operates at maximum power)
>
> • increase the CPE antenna height to allow a better signal path where required (suitable solution)
>
> • increase the CPE antenna gain, such as using longer antenna or a directional yagi antenna rather than an omni-directional antenna (suitable solution)
>
> • move the CPE to a location that avoids obstructions (suitable solution if there is an appropriate location close by).

[62] Network Strategies, 'within coverage v5 – restricted.xls', tab 'Unit Costs', cell: c29,c36
[63] Network Strategies, *Submission on Revised Draft Determination 2003-04*, 14 December 2006, p12
[64] Ibid p13-4

Model Synthesis

WLL Radio Cap

456. The WLL radio was first used in the 2002/2003 determination and is used again in 2003/2004. The cap for these periods was set at the weighted average cost of the ESA's listed in Table 44 and Table 46 respectively.

457. The 2003/2004 TSO determination saw the introduction of the MT cap. At this time the ESAs were classified into 'rolling' and 'non rolling terrain'. MT was generally the least expensive technology for the rolling terrain. These categorisations of ESA were retained. Table 46 the WLL radio cap is only able to be applied to those ESA that are deemed suitable for this technology. These ESA are listed in 'c:\hcpm\tso\wk_lib\hcpm\wll.csv'. A selection of these ESAs has had a detail design produced one that provides technical details but also annualised per customer costs. These costs have been reviewed and those costs that best represented the process costs have been averaged. This average has then been applied as a cap to those ESAs where this technology can be applied.

Table 44: WLL Radio Cap 2003/2004

Step	ESA	Customer Cost (pa)	Weight	Lines	Type
A	HDS	$[ ]	1	[ ]	State Highway/Coastal
A	WIL	$[ ]	1	[ ]	State Highway/Coastal
A	MFD	$[ ]	1	[ ]	Inland Plain
A	ARD	$[ ]	1	[ ]	Inland/Foothills
A	WSF	$[ ]	1	[ ]	Inland Plain
A	WCM	$[ ]	1	[ ]	Inland Plain
A	SB	$[ ]	1	[ ]	Inland/Foothills
B	OTU	$[ ]	0	[ ]	Inland Rolling Plain
B	STA	$[ ]	0	[ ]	Coastal Plain & Foothills
B	CAV	$[ ]	0	[ ]	Inland Foothills/Sparse
C	MAO	$[ ]	1	[ ]	Rolling Hill/Sparse
C	WRM	$[ ]	1	[ ]	Rolling Hill/Sparse
D	PTO	$[ ]	1	[ ]	Hills/Very Sparse
D	THE	$[ ]	1	[ ]	Hills/Very Sparse
	Average	$[ ]			

Lines TCNZRI, Customer cost CCRI

Table 45: Mobile Technologies Radio Cap 2003/2004

Step	ESA	Customer Cost (pa)	Weight	Lines	Type
A	HDS	$[ ]	0	[ ]	State Highway/Coastal
A	WIL	$[ ]	0	[ ]	State Highway/Coastal
A	MFD	$[ ]	0	[ ]	Inland Plain
A	ARD	$[ ]	0	[ ]	Inland/Foothills
A	WSF	$[ ]	0	[ ]	Inland Plain
A	WCM	$[ ]	0	[ ]	Inland Plain
A	SB	$[ ]	0	[ ]	Inland/Foothills
B	OTU	$[ ]	1	[ ]	Inland Rolling Plain
B	STA	$[ ]	1	[ ]	Coastal Plain & Foothills
B	CAV	$[ ]	1	[ ]	Inland Foothills/Sparse
C	MAO	$[ ]	0	[ ]	Rolling Hill/Sparse
C	WRM	$[ ]	0	[ ]	Rolling Hill/Sparse

D	PTO	$[ ]	0	[ ]	Hills/Very Sparse
D	THE	$[ ]	0	[ ]	Hills/Very Sparse
	Average	$[ ]			

Lines TCNZRI, Customer cost CCRI

458. The average on tables Table 44, to Table 47 is calculated as follows:

$$average = \frac{\sum_i c_i w_i l_i}{\sum_i w_i l_i}$$ for all 'i' 'the rows' from the relevant table.

Where:

c_i = the average cost the 'Customer Cost' for an ESA
w_i = the weighting for an ESA 'the weight'
l_i = the number of lines for that ESA

459. The Commission's modelling applies a single line of sight (LOS) technology (Airspan) to serve all customers in the target ESAs.

460. The Commission's model identifies Wireless Local Loop annual costs per customer, using Airspan 4000 equipment designs for each ESA in the four sample areas. The costing is performed at the Commission's TSO WACC of 7.4% and uses Commission defined tilts and asset lives consistent with CostProNZ and HCPM modelling. Equipment pricing and financial parameters not defined in the Commission's modelling to date have been provided by Gibson Quai – AAS. These model inputs are consistent with industry practice and are detailed in the 'Technology Inputs' work-sheet of the GQ-AAS model located at 'c:\hcpm\model_lib\GQ_radio_model' on the distribution program suite.

461. The 2005/2006 radio cap was updated as per the following table :

Table 46: WLL Radio Cap 2005/2006

Step	ESA	Customer Cost (pa)	Customer Cost NPV	Weight	Lines
A	HDS	$[ ]	$[ ]	1	[ ]
A	WIL	$[ ]	$[ ]	1	[ ]
A	MFD	$[ ]	$[ ]	1	[ ]
A	ARD	$[ ]	$[ ]	1	[ ]
A	WSF	$[ ]	$[ ]	1	[ ]
A	WCM	$[ ]	$[ ]	1	[ ]
A	SB	$[ ]	$[ ]	1	[ ]
B	OTU	$[ ]	$[ ]	0	[ ]
B	STA	$[ ]	$[ ]	0	[ ]
B	CAV	$[ ]	$[ ]	0	[ ]
C	MAO	$[ ]	$[ ]	1	[ ]
C	WRM	$[ ]	$[ ]	1	[ ]
D	PTO	$[ ]	$[ ]	1	[ ]
D	THE	$[ ]	$[ ]	1	[ ]
	Average	$[ ]	$[ ]		

Lines TCNZRI, Customer cost CCRI

GSM Radio Cap

462. GQ-AAS has advised the Commission that mobile radio technologies had evolved to a point where they could cost effectively provide fixed radio solutions meeting the technological requirements of the TSO calculation. Mobile Technologies had an advantage over the WLL technologies for cap for rolling plains but not for non rolling plains. The Mobile Technologies radio cap is only able to be applied to those ESA that are deemed suitable for this technology. The costs of this cap were produced as follows.

Table 47: Mobile Technologies Radio Cap 2005/2006

Step	ESA	Customer Cost NPV	Customer Cost NPV	Weight	Lines
A	HDS	$[ ]	$[ ]	0	[ ]
A	WIL	$[ ]	$[ ]	0	[ ]
A	MFD	$[ ]	$[ ]	0	[ ]
A	ARD	$[ ]	$[ ]	0	[ ]
A	WSF	$[ ]	$[ ]	0	[ ]
A	WCM	$[ ]	$[ ]	0	[ ]
A	SB	$[ ]	$[ ]	0	[ ]
B	OTU	$[ ]	$[ ]	1	[ ]
B	STA	$[ ]	$[ ]	1	[ ]
B	CAV	$[ ]	$[ ]	1	[ ]
C	MAO	$[ ]	$[ ]	0	[ ]
C	WRM	$[ ]	$[ ]	0	[ ]
D	PTO	$[ ]	$[ ]	0	[ ]
D	THE	$[ ]	$[ ]	0	[ ]
	Average	$[ ]	$[ ]		

Lines TCNZRI, Customer cost CCRI

463. The Commission's model identifies MT annual costs per customer, using GSM equipment designs for each ESA in the four sample areas. The costing is performed at the Commission's TSO WACC of 7.4% and uses Commission defined tilts and asset lives consistent with CostProNZ and HCPM modelling. Equipment pricing and financial parameters not defined in the Commission's modelling to date have been provided by Gibson Quai – AAS. These model inputs are consistent with industry practice and are detailed in the 'Technology Inputs' work-sheet of the model located at 'c:\hcpm\model_lib\GQ_radio_model' on the distribution program suite.

464. Results from the model are tabulated below:

Table 48: Results of Commission Radio Cap Modelling for 2005/2006

Technology	Annualised Cap Value ($/access line)	NPV Cap Value ($/access line)
WLL	$[ ]	$[ ]
MT (GSM)	$[ ]	$[ ]

Modelling Implications

Application of the Radio Cap

465. The Commission has developed a cost model of the radio local loop as a TSO access method. This modelling was performed by Gibson Quai – AAS. It is based on the cost and performance of Airspan series 4000 radio systems GSM technology and customer premises equipment.

466. The cost model is provided as part of the 2003/2004 TSO model distribution and is contained in the spreadsheet 'C:\hcpm\model_lib\GQ_radio_model\TSO Wireless Cap Access Model rev 11 March 07CC.xls'.

467. The Commission's analysis of the Gibson Quai – AAS model is detailed in Table 46 and Table 47. It develops a weighted average WLL customer cost of $[ ] per annum for areas of plain and rolling plain geography. This technology has a corresponding NPV per customer of $[ ] A mobile technology cap based on GSM has an average customer cost of $[ ] per annum for rolling plains. The corresponding NPV is [ ]. The Commission considers that these are appropriate radio cost caps for these and geographically similar rural ESAs.

468. The Commission has identified 201 ESAs with similar geography and has tagged these within the TSO model by means of the various 'wll.csv' files located under c:\HCPM\TSO\wk_lib'. When encountered, these ESAs are modelled with the radio cap set to $[ ] per annum and a NPV of $[ ]. A subset of the WLL ESA's has been identified which are suitable for use with mobile technology. These ESA's are characterised by having rolling plains. They are identified in file 'c:\hcpm\tso\wk_lib\' For all other ESA geographies, WLL and mobile technology costs are unpredictable, being highly dependent on customer locations, and the conventional (multi-access radio) cost cap remains in place.

469. The TSO program examines each cluster to confirm if that cluster would be better served by one of the three radio solutions or by the largely copper network based design supported by the HCPM model. The decision sequence is documented in Figure 8 below. The logic consists of two major decisions. If the cluster is small then the cap is the smaller of the existing per customer cost and the available radio caps. If the cluster is large and if the feeder cost is a large fraction of the overall cluster cost then the costs associated with hanging[65] plant are investigated. If the per line incremental cost are greater than the various radio cap options then the cluster's costs will be capped.

[65] Hanging plant is discussed in this determination at paragraph 600.

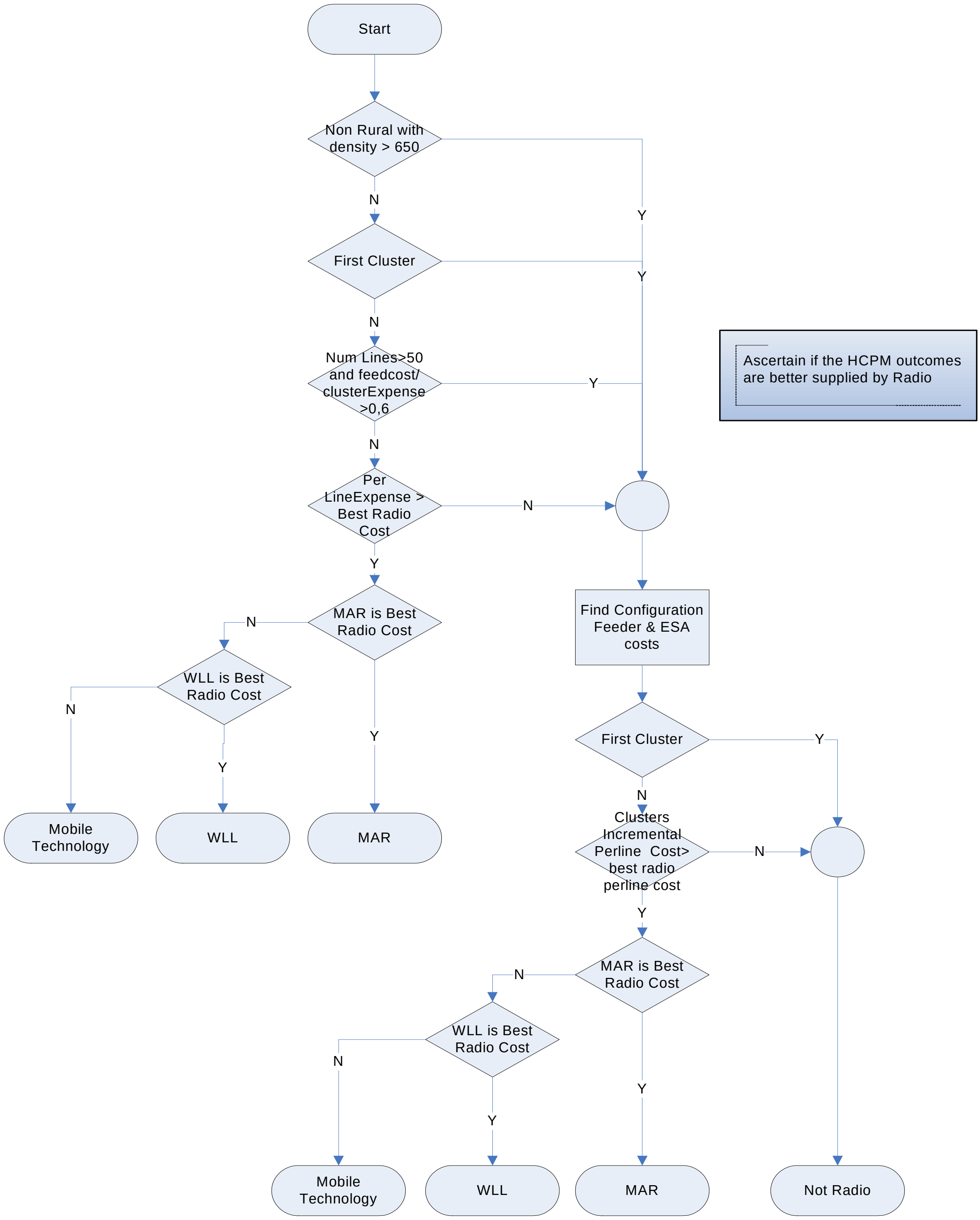

Figure 8: Capping Process

APPENDIX 4: COSTPRONZ CORE NETWORK/TRAFFIC MODELLING

Description of CostProNZ Model

470. CostProNZ calculates the LRIC cost for material and labour investments associated with the switching, signalling, and transport of landline telecommunication network functions. In conjunction with HCPM, the output from CostProNZ is used to calculate the TSO net cost.

471. CostProNZ was designed to use forward looking, commercially available telecommunications technologies. It also employs modelling algorithms which reflect the best practice of contemporary switch and transport engineering.

Incremental Calling Costs

472. In modelling the net cost of the TSO, the relevant increment is CNVCs and not all residential customers. The commercial viability of serving groups (or 'clusters') of customers is tested, and in doing so, both the access costs (associated with providing the customers with an access line) and the core costs (associated with the supply of call services) are considered.

473. In considering a particular cluster of customers, CostProNZ seeks to capture the incremental costs of supplying call services in respect of that cluster. Specifically, for that cluster, CostProNZ focuses on the incremental costs associated with:

- Free local calling – standard voice calls;
- Free local calling – standard facsimile calls;
- Free local calling – standard internet calls;
- Free genuine standard voice calls to emergency (111) service; and
- Supplementary services provided by the core network which offset the TSO loss, including tolls services and value-added services (such as Call Minder, etc).

474. CostProNZ complements the access model by estimating the incremental cost of calls for commercially non-viable customers. CostProNZ provides incremental cost information and cost-volume relationships, which are used in the HCPM cluster manipulation process to test areas and groups of customers for commercial viability. The output from CostProNZ feeds into the estimation of the total net incremental cost of providing service to a customer group, and allows comparison with gross revenue figures provided by Telecom.

475. As the Commission has noted previously,

> In the context of the TSO, the incremental cost of an obligation to provide services to a commercially non-viable customer is therefore equal to the difference in the firm's total costs between when it supplies that customer in conjunction with all its other customers, and when it does not.[66]

476. To the extent that costs are fixed and common across CNVCs and commercially viable customers, those costs should not be included in the incremental cost of the TSO. Such costs would continue to be incurred irrespective of whether the CNVCs are served.

[66] Commerce Commission, *TSO Cornerstone Issues Discussion Paper*, p 11.

477. However, in the modelling of the incremental calling costs associated with the TSO, the extent to which the obligation to supply service to CNVCs requires an increment to capacity within the core network needs to be identified. For example, a switch may serve both commercially viable and commercially non-viable customers. The issue is, what is the incremental cost of supplying call services to the CNVCs?

478. The Commission has used the following method to implement LRIC. The first step is to define a 'cost object'. A cost object is anything for which the measurement of cost is appropriate. Cost objects are usually thought of as products, services, network elements, or the firm as a whole. For example, in the access network, one of the cost objects is a cluster of customers. When a cluster is tested within the access network, all of the network elements attributable to that cluster are identified and costed. However, when a cluster of customers is tested within the access network for viability, the cost driver in the core network is no longer the network elements associated with that cluster, but instead is the volume of calls that were generated by that cluster.

479. These calling costs, in conjunction with the results from the access model, are then used to determine the total net incremental cost of supplying services to that cluster of customers.

LRIC Approach Used in CostProNZ

480. LRIC is the cost avoided through no longer providing the output of a defined increment given that costs can be varied and that some level of output is already produced.

481. An increment is the output over which the costs are being measured, and theoretically there is no restriction on what products, services or outputs could collectively or individually form an increment. In extremis, the cost of providing an extra unit of output of a service will equal the marginal cost, while the incremental cost of providing the entire output of Telecom will equal the total cost of Telecom.

482. Incremental costs are those costs that are caused by the provision of a defined increment of output. Equivalently, incremental costs can be defined as those costs that are avoided by not providing the increment of output.

483. As a case in point, the fixed Public Data Network (FPDN) and the PSTN can be said to have costs which are common between them. However, assuming that both a quantity of both FPDN and PSTN traffic is already being transmitted, TSO traffic is only incremental to the volume of traffic traversing the PSTN network.

484. Therefore, the capacity to which the transport network has been sized is based on the call volumes of free local calling (voice, facsimile and internet calls) and any other supplementary call volumes as defined by the Act. This suggests that the LRIC costs represent the avoidable costs of the provision of TSO services over the PSTN network.

485. The impact on the costs of no longer providing the defined increment is measured taking a long run view. This allows all costs that do vary (even if only in the long term) to adjust to the change on output.

Sharing of core costs between voice and data networks

486. The Commission's models prior to CostProNZ v2.0 had not explicitly modelled the shared core costs between voice and data networks. It had instead used modified structure sharing percentages. Post CostProNZ v2.0 these costs have been explicitly

handled by the model. The percentages are on presented Table 56: CostProNZ Sharing Assumptions for Core Network.

Modelling the TSO increment

487. For the network modelling exercise, CostProNZ has used three major cost objects: cluster, exchanges (wire centre) and traffic (defined in the model as lines, minutes of usage and calls set up). The cluster has been discussed above and is typically related to the access network. The exchange cost object includes some core network assets and some access network assets. This is a key cost driver since there are some costs within the exchange that would be considered fixed with respect to individual clusters but might be considered variable within the exchange cost object. The last cost object is the volume of traffic. As clusters of customers within the access network are tested, there will be a flow-on effect into the core network, where the cost of those volumes of calls traversing the switches and transmission lines will be valued. These calls include local calls, as well as any included supplementary call services such as toll calls and fixed-to-mobile calls.

488. Figure 9: Asset classification Decision Tree shows the typical decisions that will be made in order to classify each asset based on the change in increment of a particular cost object.

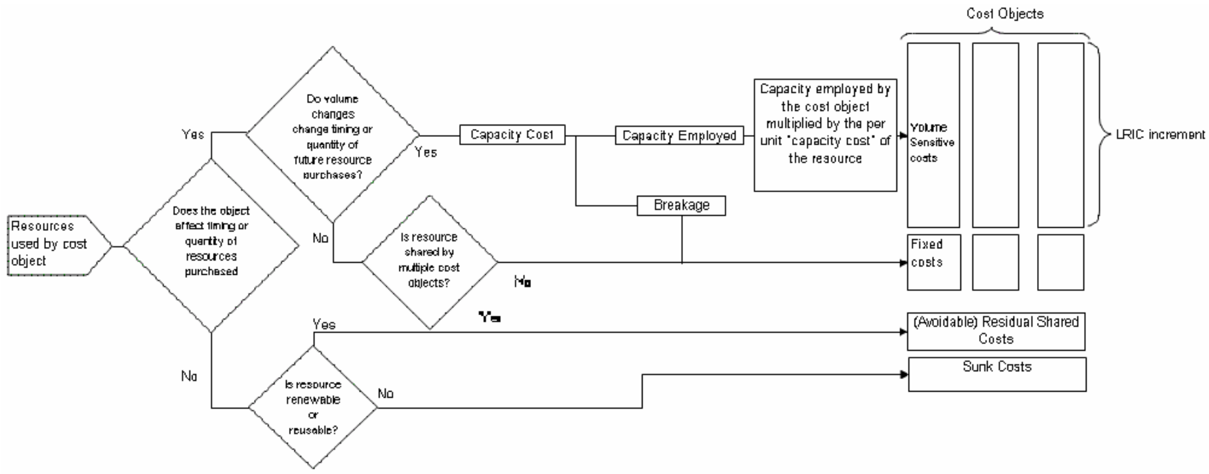

Figure 9: Asset classification Decision Tree

489. In Figure 9: Asset classification Decision Tree there is a split between 'Capacity Employed' and 'Breakage'. These terms are used to address the problem of costing the 'lumpy' nature of telecommunications assets. The technique to be used to address the costing of these lumps of investment is called 'Capacity Costing'. This is a way of apportioning the cost of used and unused capacity in a given asset lump. If the asset has a total cost of $x, and a total number of useable units C, then the apportioning of the costs per unit of capacity is simply $x/C. This value is the per unit capacity cost of the asset. The 'Breakage' term relates to the distinction between used and unused capacity. The used capacity ('Capacity Employed' in the diagram) is multiplied by the per unit capacity cost in order to find the total volume sensitive costs used in the increment. The capacity which is not employed is considered to be a fixed cost and is not used in the LRIC increment.

490. In other words, where the TSP has invested in incremental capacity with which to serve CNVCs, only that part of the capacity which is actually utilised is included in

CostProNZ. The unused capacity is excluded (until the point at which that capacity is actually taken up).

491. For example, consider a switch that has a capital cost of $100, a capacity of 100 units and therefore a unit capacity cost of $1. Now suppose that the used capacity amounts to 80 units, and that two equal clusters of customers are served by that switch. In testing the viability of one of those clusters, the costs of serving those 40 units are considered. CostProNZ takes the incremental capacity as being the 40 units, and determines the cost associated with those units ($40).

492. Having determined the incremental capital associated with the cost object, an annualisation factor is applied in order to generate an annual capital cost, incorporating both a return on capital and a return of capital. This is by application of a tilted annuity to the incremental capital. The annuity term includes both a return of capital (depreciation) and a return on capital.

493. The Commission's cost modelling has focussed on the capital costs of supplying TSO services to CNVCs. However, in addition to these costs, an efficient provider will incur a range of non-network operating and maintenance costs.

494. The Commission has therefore included an adjustment to reflect the level of operating expenditure ('opex'). The Commission believes that it is appropriate to treat opex as a function of the capital value of the network, and has therefore applied a fixed percentage to the capital base. This approach is also consistent with that followed by regulators in other jurisdictions.

495. The Commission believes that the best available indicator of the level of opex required to service and maintain a TSO services network in New Zealand is that provided by the TSP itself. Telecom has provided the Commission with a detailed analysis of the level of opex that it incurs and the Commission has developed this into a percentage value of total capital employed in CostProNZ.

CostProNZ Cost Types

496. CostProNZ employs the following definitions of costs.[67]

> ***Directly Attributable Costs** are those costs that are incurred as a direct result of the provision of a particular service in a particular increment. These costs fall into two types. First, the costs of some inputs vary with the level of output, so that even if the production of more than one service requires this input, the extent to which a single service causes the costs can be calculated. Second, there are assets and operating costs which are fixed with respect to the level of output but which are service specific.*
>
> ***Shared Costs** are the costs of those inputs necessary to produce two or more services within the same cost increment, where it is not possible to identify the extent to which a specific service causes the cost. Examples of shared costs in the core network include optical fibre, transmission equipment and related overheads, all used by PSTN, leased line and data services.*
>
> ***Common Costs** are the costs of those inputs necessary to produce one or more services in two or more increments, where it is not possible to identify the extent to which a specific increment causes the cost. Trenching costs provide a good example of the difference between shared and common costs. The costs of trenching specific to the access network (or the core network) will generally be shared costs since it is likely to be used by two or more services. However, some trenching will be used by both the access and the core network. In these instances, the costs will be common costs.*

[67] *version 2, CostPro*NZ Methodology Manual,* P 12

Best Practice Engineering Design Rules for the Model

497. CostProNZ's design approach puts much of the logic and network design into user adjustable inputs so that the platform is flexible to meet changing / evolving requirements. For example, options exist for the user to place Carrier type equipment to serve smaller ESAs.

498. As a guiding set of principles (but not exhaustive):

- CostProNZ will handle switchless ESA linking costs as required by HCPM;
- the latest, currently deployed technologies are used at each point of the CostProNZ network;
- transport facilities are sized to meet demand on each route;
- transport nodes are sized to meet demand on each route;
- transport nodes are engineered to use the most economical technology (e.g., radio versus fibre);
- transport rings are determined based on new designs:
- point to point architecture is used where appropriate and is partially controlled by a user input specifying survivability requirements;
- transport modelled distance are based on road routing;
- switching components are sized to meet demand and projected growth on each route; and
- switching technology at each site is selected to recognize size of site and so that appropriate equipment (61E, RLU, etc) is placed, depending on the user input. In certain instances (as guided by user inputs) the model will deploy Carrier type systems in smaller ESAs.

Costs Captured When a Whole ESA is Unprofitable

499. CostProNZ accounts for exchange, land, and building costs for all ESAs in New Zealand. How those costs are reported is based on the user's reporting selections.

500. Land and building are based on factors of the exchange investment. Typically in examining the profitability of a group of customers, the use of ESA Capacity Costs from the CostProNZ reporting is appropriate. These capacity costs, as described above, include the long run costs incurred by those customers (whether it is line, usage, or call driven costs). However, the user has the choice to include only those costs considered Direct (CostType = 'D'), Shared (CostType = 'S'), Common (CostType = 'C'), or a combination. If the user selects a CostType of S or C, the output costs will include land building, and non-volume sensitive components of the network. While these costs are Shared or Common by nature, they are unitized in the same manner as the Direct costs they are associated with. For example, since land and building costs are developed by factors applied to investment, the capacity costs for land and building are based on the capacity costs of the exchange investment.

501. If the user wants to understand the costs incurred by the entire exchange when it is shown to be unprofitable, the user can include the Direct ESA Costs in reporting. By selecting this field, the user can now understand what costs, in addition to the capacity costs, could be avoided if the exchange was not served (alternatively, the additional costs that are incurred when the exchange is served).

Incremental Cost Calculations

502. Incremental costs in CostProNZ are based upon the capacity cost techniques described above. That is, what portion of the useable capacity is the cost object consuming? To develop the useable capacity and the total installed plant, each network component was reviewed to determine the major cost driver (lines, usage, or calls). With the total volumes of the cost drivers, the model then develops the quantity of components needed and the total installed amount of useable capacity.

503. For some components, the cost driver is an ESA, a route, or a ring. For these costs, the total costs were uniquely developed based on the component. For example, the amount of fibre on a ring is based on distance. For these Shared and Common portions of the network, the capacity utilisation (based on lines, usage and calls) is zero since the costs are fixed over a broader base. However, for reporting purposes, these shared and common costs are unitized based on the cost driver volumes the item supports (e.g. for fibre and structure, the capacity is based upon the number of E1s traversing the segments) or in the instance of land and buildings, it is based on the same proportion as the direct capacity costs of the switch.

504. Capacity costs do not include the unused capacity of the components. To include the unused capacity of the investments in the reporting, the user can select working cost fields. In effect, the Working cost fields represent the unitization of the network investments by the working capacity rather than the useable capacity. This Working cost is akin to the FCC's TELRIC costs.

505. As a broad guide, the following provides the increments and drivers of the basic assets in the core network:

- Transport Electronics: The basic driver of transport electronics (SDHSystem, SDHPlugins, SDHRegenerator, DCSSystem, DCSPlugins, RadioSystem, RadioTowers, RadioPlugins) is the minutes of use touching the system. While some of the costs are fixed for the ESA (Radio Tower), all costs are unitized over the installed capacity of usage at the system or in the plug-in cards. Usage is derived from the installed E1s at the site. The E1s are derived based upon the user input for Erlangs Per Trunk and the actual traffic touching the node.
- DLC: DLC is used as an alternative to switching at very low volume ESAs. The Digital Loop Carrier (DLC) system, aggregates and concentrates traffic for transport over fibre back to a host exchange. DLC systems are sized based upon the channels and lines terminating at the system. As such, the system and plug-in card's installed investment is unitized over the lines the system and plug-in cards will support.
- Fibre and Structure: The fibre and structure investments are heavily dependent upon the road distances between transport segments. Most of the transport segments are within a ring that connects numerous ESAs along a shared, redundant, connecting path. However, a few ESAs are isolated and more cost effectively served by running spur (i.e. point to point) segments out to the ESA. In either case, CostProNZ captures the total designed traffic over each segment to determine the segment's capacity. For example, a transport segment from ESA A to B may have a remote to host ring's traffic, a host to tandem ring's traffic, and the tandem to gateway ring's traffic. Using the sum of the traffic, the segment's investment is unitized to the designed traffic over the segment. This designed traffic is derived from the E1s on the transmission

plug-in connected to the system and the Erlangs per Trunk the E1s are assumed to support. While the spur calculation is similar, the amount of traffic over the spur may be much less since it is less likely to be the route for higher level transport rings.

- Switching: Switching investment is made up of multiple components, many of which are driven by differing cost drivers. For example, the line cards of the switch are driven by the number of lines terminating at the switch. The ringer component is driven by the number of calls, while the trunk cards of the switch are, in effect, driven by the usage emanating from the lines connected to the switch. Using the capacity of each component (or the best approximation), the component's investment is unitized based on the installed capacity.
- Land and Building: Land and building are loaded via a factor in CostProNZ. As such, they are assumed to follow the same characteristics as the investment they are loaded against.

CostProNZ Modelling Inputs

506. The inputs required for CostProNZ can be broken down into three major categories: engineering design rules, asset price information and financial parameters.

Engineering Design Rules

507. The engineering design rules are used to lay out the appropriate network assets and dimension the capacity of the network according to demand. For example: what maximum number of lines should an RLU host before being resized as a local switch, or what different types of assets should be used in particular scenarios, such as at what distances DMR is substituted for submarine fibre? .

Asset Price Data

508. The asset prices are used to develop a total capital cost of the modelled network. These costs can be divided into two categories; assets required for the switching of calls and assets required for transporting calls between switches (transmission). Of principal concern to the Commission is that in gathering information on appropriate asset prices, all care is taken in collecting data which is applicable to the New Zealand commercial environment and that consistency is maintained across the network.

509. With regard to the asset prices, the Commission is cognizant of the fact that Telecom may receive discounts which are specific to the New Zealand commercial environment. These discounts may be based on Telecom's purchasing power, the strategic advantage a vendor may see in having its products placed in New Zealand or the population distribution in New Zealand and its specific geographic characteristics. With these issues in mind the Commission does not believe it is appropriate to take the list prices of overseas vendors and make the necessary adjustments to these prices in order to obtain a New Zealand specific pricing structure. To this end the Commission has looked to source asset prices that would actually be applicable to the roll out of a TSO services network in New Zealand.

510. In the case of the consistency of the information the Commission gathers, there are two issues: that the assets for which information is collected represent all of the assets required for the provision of TSO services without omission or replication, and that the assets used in the network are compatible with respect to the design of the whole network. With this in mind, the Commission asked all liable persons and Telecom to provide asset price information.

Financial Inputs

511. The financial parameters are used to turn the total capital cost of the network into an annualised capital cost. This process uses the tilted annuity formula as discussed in the Commission's 'TSO Implementation Issues'[68] paper which takes as its inputs the categories of:

Tilt	The rate of change in the price of the assets,
Asset Life	The economic life of the asset,
WACC	Weighted Average Cost of Capital,
Opex	Operational Expenditure.

The values of these parameters that have been adopted by the Commission are detailed in the following tables.

CostProNZ Model Parameters

Financial Parameters

512. CostProNZ financial parameters are shown below.

Table 49: CostProNZ Financial Parameters

Asset Category	Real Tilt	Nominal Tilt	Time To Build	Asset Life	Opex Rate
Aerial Fibre	[ ]	[ ]	0.5	14	4.3%
Building	[ ]	[ ]	0.5	50	2.8%
Buried Fibre	[ ]	[ ]	0.5	20	4.3%
Circuit	[ ]	[ ]	0.5	8	4.3%
Conduit	[ ]	[ ]	0.5	50	4.3%
Land	[ ]	[ ]	0	1000	2.8%
Pole	[ ]	[ ]	0.5	14	4.3%
Radio	[ ]	[ ]	0.5	10	4.3%
Submarine Fibre	[ ]	[ ]	0.5	20	4.3%
Switch	[ ]	[ ]	0.25	10	2.8%
Underground Fibre	[ ]	[ ]	0.5	20	4.3%

Trenching Costs

513. Trenching costs and activity percentages in CostProNZ have been updated to better match those developed for HCPM.

[68] Commerce Commission, *TSO Discussion Paper and Practice Note – Implementation Issues Paper*, 19 April 2002

Table 50: CostProNZ Trenching and Activity Costs

Density Area	Activity	Base Cost	Pct Activity	Pct Assign Phone	Normal	Soft Rock	Hard Rock
Metro	Plow	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Metro	Trench & Backfill	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Metro	Asphalt Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Metro	Concrete Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Urban	Plow	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Urban	Trench & Backfill	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Urban	Asphalt Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Urban	Concrete Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Suburban	Plow	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Suburban	Trench & Backfill	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Suburban	Asphalt Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Suburban	Concrete Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Rural	Plow	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Rural	Trench & Backfill	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Rural	Asphalt Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%
Rural	Concrete Trench	$[ ]	[ ]%	[ ]%	[ ]%	[ ]%	[ ]%

514. These values are applied in conjunction with 'structure sharing' and 'structure density factors' to calculate the actual cost per metre for each structure type. For the purposes of this determination, structure sharing factors are unchanged and structure density factors are set to 100% for all terrain types.

Engineering Design Rules

515. Other CostProNZ engineering design rules are unchanged from the 2001/2002 TSO Determination.

Asset Prices

516. For each asset listed in the inputs for the CostProNZ model, there is a brief description of the input and what the source of the data is.

CostProNZ Model Inputs

517. The 'C:\Program Files\CostProNZ\Scenarios' directory four directories supplied by the Commission they are HCPM, HCPM0304v22, HCPM0405v22, HCPM0506v22 corresponding 2002/2003 through 2005/2006 respectively. Each subdirectory has its own access database being the complete set of CostProNZ scenario files for that year. Within each CostProNZ database there are the following tables

Table 51: CostProNZ tables

Table	Static	Update for each determination	Feed from hcpm->costpro	update for tslric	Description
tblAbout	X				Version info
tblCallTrafficSensitivity	X				Call Traffic Scale Factor
tblCNVC		set to 0	X	populate with cnvc	Cnvc by ESA
tblCOMAnnCapCostFactors	X				Annualisation Capital Cost Factors
tblCOMAssetClassification	X				Asset Classification against asset portfolios
tblCOMTouchCostElements	X				Switch Traffic vs. plant the traffic touches
tblCSVHcpm	X				Bus res and copper line counts by ESA
tblCSVRingPaths	X				Logical SDH ring paths
tblCSVRingPathsAirline	X				Airline distance length of ring segments
tblCSVTerrainDensity	X		X		Density & terrain % by ESA
tblDataTraffic		Refresh		= <-	Data E1 counts in SDH rings
tblINVRingElec					work space
tblINVRingFacility					work space
tblINVSwitching					work space
tblLICA	X				List of LICA
tblRoadDistances	X				From-To ESA Lat/Lon & road dist
tblRPTReport					work space
tblRPTTSLRICDensityCallType					work space
tblRPTTSLRICLICACallType					work space
tblRPTTSLRICLICAGroupCallType					work space
tblRPTTSLRICSimpleCallType					work space
tblSimpleCallType	X				
tblStats	X				CostPro Internal
tblSUMCapToWorkFactors					work space
tblSUMESATransportCosts					work space
tblSUMRingCosts					work space
tblSUMRingCostsSummary					work space
tblSUMRingParentNode					work space
tblSUMRingPathCost					work space
tblSUMRingRemoteNodes					work space
tblSUMTransportInstalledCost					work space
tblSUMTransportUtilizedCost					work space
tblSWAddlPSTNCosts	X				Costs not otherwise caught in the model
tblSWCallTypeUsage		refresh			call type usage by ESA
tblSWDiscount	X				Vendor discounts
tblSWEngineeringRules	X				Distances technologies work over
tblSWFeatureCounts		X		X	Feature penetration
tblSWFeaturesLinePenetration	X				Lines type average penetration
tblSWFillFactors	X				Max user capacity before expansion needed
tblSWGrowthRate	X				forecast growth
tblSWITU7Invest	X				switch & related costs
tblSWITU7SCP	X				SCP Costs
tblSWITU7STP	X				STP Dimensioning
tblSWLaborRates	X				Engineering labour rates
tblSWMiscFactors	X				Aircond, power plants etc
tblSWNetworkTraffic	X				Design info - busy hours erlangs, call completion ratios
tblSWSwitchDimension	X				switch dimensioning ringers, pra, bra etc
tblSWSwitchSub61E	X				61 e switch dimensioning
tblSWSwitchSubRemotes	X				RLU dimensioning
tblSWTouch	X				Call type touch table
tblSWType	X				Type of switch at each ESA
tblSYSCallTypeTraffic					work space
tblSYSDensityTypes					work space
tblSYSESASWMaster					work space
tblSYSHcpmIN					work space
tblSYSNodeMaster					work space
tblSYSRingPathMaster					work space
tblSYSRings					work space
tblSYSRingTraffic					work space
tblSYSRingTypes					work space
tblSYSTempRings					work space
tblTMPAnnCapCostPct					work space

Table	Static	Update for each determination	Feed from hcpm->costpro	update for tslric	Description
tblTMPCallTypeQtyByTouch					work space
tblTMPCallTypeUsage					work space
tblTMPCostUOMForCallTypeReports					work space
tblTMPDataE1					work space
tblTMPDataE1Prelim					work space
tblTMPESADataPaths					work space
tblTMPInstalledE1sBySwType					work space
tblTMPNonCNVCPct					work space
tblTMPRingTraffic					work space
tblTMPSumNodes					work space
tblTRAerialStruct	X				Aerial structure costs
tblTRCOFiberTerm	X				fiber termination
tblTRDensity	X				Teledensity relation to area type
tblTRDensityFactors	X				Density metro/ urban/suburban/rural
tblTRDigitalMWRadio	X				DMR Costs
tblTREngineeringRules	X				fiber engineering rules
tblTRFiber	X				unit cost of fiber
tblTRFiberPlantMix	X				Underground/ overhead … mix fr fiber
tblTRFillFactors	X				Trans trigger invest fill factors
tblTRInstallationFactors	X				engineering design factors
tblTRManhole	X				manhole unit costs
tblTRMHPoleSpacing	X				distance between poles
tblTRMiscInvestFactors	X				engineering design factors
tblTROptDistFrameBlk	X				unit costs of optical distribution blocks
tblTRRadioTower	X				unit cost radio towers
tblTRRmtFiberTerm	X				fiber termination costs
tblTRRptrEquipTower	X				tower associated costs
tblTRStructureSharing	X	X diff assump		X diff assump	structure sharing costs (there are different sharing assumptions between the TSO and TSLRIC models.
tblTRTransEquip	X				transmission equip costs
tblTRTrench	X				trenching unit costs
tblUAIStudyType		"TSO"		"TSLRIC"	Mode switch

Remote Fibre Terminal, 1440 size

518. Telecom submits that the 'Remote Fibre Terminal', 1440 size (see tblTRRmtFiberTerm) should be set back to 4 times that of a 360 system, which is the largest size used in practice by Telecom.

519. The Commission has decided to retain the larger size fiber terminal as it considers that an efficient provider would use the larger terminal.

Remote Fibre Terminal, 120 size

520. Telecom submits that the price for the 60-line system is relatively low compared to the Remote Fibre Terminal, 120 size (tblTRRmtFiberTerm) due to the 60-line system being designed especially for low density rural areas, whereas the 120-line system is a completely different system.

521. The Commission considers that a 120 line system is a reasonable technology to deploy.

Update Switch/RLU UPS prices

522. Telecom submits that the labour installation component within the switch unit prices should be based on actual contract prices rather than on BOP estimated man-hours per frame.

Table 52: Switching Subsystems 61E LX/RX/NX/IX

Item	2Mb DDF	MDF Term	2Mb LTE	NEAX Equip	Labour	Power/AirCond	Sub Total
Traffic-Driven Investment Items							
61E Ringer Module	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Primary Multiplexer (excl NW and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
ISDN LCPM (for BRA/HDTM, excl NW and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
ISDN LCPM (for PRA, excl NW and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
2Mb Digital Trunk Interface (excl NW and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
2Mb Host Digital Trunk Interface (excl NW and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
101 N/W (including TSCPF and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
101E N/W (including TSCPF and CP)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
General 101E Set Up (Excluding SS7)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
General 101 Set Up (Excluding SS7)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
101E CCSPF Set Up (Excluding SS7 links)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
101 CCSPF Set Up (Excluding SS7 Links)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
SS7 Link (Excluding CCSPF)	[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
2Mb RDLU Digital Trunk Interface (on RDLU or Host HDTM)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Line-Driven Investment Items							
A-8LC Line	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
A-4LC Line	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
A-4LT Line	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
DTLM 2Mb Termination (30 lines)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Investment per BRA Line (excluding LCPM)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Investment per PRA Line (excluding LCPM)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Investment per HDTM (for RDLU) (excluding DTI's)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Fixed ISDN Investment	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**

TCNZRI

Table 53: Switching Subsystems RLU

Item	2Mb DDF	MDF Term	2Mb LTE	NEAX Equip	Labour	Power/AirCond	Sub Total
Traffic-Driven Investment Items							
RLU Ringer Module	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Remote Local Controller (RLOC) (including DTI's)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
General RLU Set-Up Investment per RLU.	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
General RLU Set-Up Investment per RLU Site.	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
2Mb RDLU Digital Trunk Interface (on RDLU or Host HDTM)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Line-Driven Investment Items							
RLU A-8LC Line	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
RLU A-4LC Line	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
RLU A-4LT Line	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
RLU DTLM 2Mb Termination (30 lines)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Investment per BRA Line (excluding RDTF)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Investment per RDLU RDTF	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**
Investment per RDLU Test Module (including test lines)	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	**$[ ]**

TCNZRI

Table 54: ITU No. 7 Signalling Investment Inputs

Item Description	2Mb DDF	MDF Term	2Mb LTE	NEAX Equip	Labour	Power/AirCond	Sub Total
Gen Setup Investment per STP.	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]
Investment per SS7 Link on STP.	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]
Investment per STP CPM	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]	$[ ]

TCNZRI

Table 55: SS7 Link

# of SS7 Links				
STP	# of CPM's	Working	Installed	Total Invest.
STP1 (POP5)	[ ]	[ ]	[ ]	$[ ]
STP2 (HN6)	[ ]	[ ]	[ ]	$[ ]
STP3 (PRO4)	[ ]	[ ]	[ ]	$[ ]
STP4 (CH8)	[ ]	[ ]	[ ]	$[ ]
Totals	[ ]	[ ]	[ ]	$[ ]

TCNZRI

523. The Commission has recognised that this rate will represent a New Zealand labour rate for NEAX technologies. The CostProNZ software has been updated.

Touch tables specific to each ESA

524. Telecom submits that traffic routing is ESA specific. Each ESA should have its own specific touch table.

525. The Commission has accepted Telecom's submission. The CostProNZ software has been updated.

Traffic Sharing

526. Telecom submits that hard coded 0.2 factor used in the model as an assumed traffic sharing ratio for traffic that goes to the Host to Host ring from remote should be replaced by additional ESA and call type specific parameters in the touch table, given that describing how traffic is meant to be routed is this table's function, and that this factor is, in reality, very ESA and call type specific.

527. The coding of the 0.2 factor has been changed from being hard coded into a table lookup. The Commission instructed CostQuest to make the 0.2 factor a variable in CostProNZ. The variable input resides in tblTREngineeringRules. The variable name for the input is RemoteToHostTrafficPctAssumption. To navigate to the input from the User interface, the user should enter the "Inputs" area and go to "Transport / Telco Miscellaneous / Engineering Inputs".

Mapping of NetBits traffic categories to CostProNZ Call Types, and input Traffic rates:

528. Telecom submits that it understands that NetBits call categories ic06, ic07, ic08, and ic09 (which are all internet calls incoming from alternative networks) have been mapped to the CostProNZ call type "Dial-up Internet", as though this traffic originates from Telecom Fixed line customers. Telecom has concerns as to what effect mapping this traffic this way will have on the accuracy of the results.

529. The Commission provided traffic data to CostQuest already allocated into CostProNZ call types. The Commission reviewed the allocation of these call types and considers "Dial-up Internet" as the most appropriate CostProNZ call type to allocate them into.

It does not consider this allocation to significantly impact on the accuracy of the model.

Line Count Denominator for tblSWCallTypeUsage

530. Telecom submits that is it is unclear how the input traffic data in the tblSWCallTypeUsage input table has been derived, i.e. what denominators were used to derive the per customer rates (annual calls and annual MOU) by call type for each ESA. If the denominators were not the same as the total customer count for each ESA as per the tblCSVHcpm input table, then CostProNZ will not re-constitute the correct total traffic levels for each ESA, leading to incorrect dimensioning of the network and subsequent incorrect cost calculations.

531. The Commission provided CostQuest with traffic levels for CostProNZ model (tblSWCallTypUsage) – the same as those used for the HCPM model. These traffic levels have been normalised by matching them to the quarterly average line counts for the 2003/2004 period. The Commission is modelling the costs associated with serving the needs of the customers at the time that the TSO deed was signed. It has applied the updated customer traffic information. It is not dimensioning the network to replicate Telecom's network as it was in this year.

Dimensioning of E1 carrier node transmission link

532. Telecom submits that the number of E1's required on Transmission links between carrier nodes and their host are incorrectly dimensioned, as it has been assumed that these links carry concentrated traffic. This is not the case with Telecom's NEAX based PSTN.

533. The Commission considers that in a forward looking network (as modelled) it can be assumed that traffic from carrier nodes back to the switch would be concentrated. This concentration and the conversion from electrical to optic are the primary reasons to adopt the carrier technology.

NEAX Software File Costs

534. Telecom submits that the CostProNZ model still does not use the NEAX Software costs that appear in the model inputs and that get past over to the SwitchLogic workbook. Although Telecom accepts that the NEAX Software file costs are not incremental and therefore should not enter into the TSO calculation, it feels for completeness of the model and its general use for other regulatory issues that the model should be modified appropriately to use and allocate these costs.

535. TelstraClear in state[69] that the Commission should continue to model an efficient network and not be limited by technical constraints which are a direct result of Telecom's historical investment decisions.

536. In the TSLRIC determination this cost was not captured in the detailed switching logic. However, it can be assumed to be covered in the common factor. In addition, this change is not vital to the TSO determination since the costs are not incremental to the CNVCs. Accordingly no changes have been made to the model.

Land and buildings

537. TelstraClear submits that land and buildings costs:

[69] Network Strategies, *Response to Telecom's submission on the 03-04 TSO Draft Determination*, Section 2.1 – 3 and TelstraClear Cross Submission on the 03 – 04 TSO Draft Determination, para 22 – 26.

b. do not implement transmission related building and land mark-ups as these mark-ups are not necessary or appropriate when calculating TSO incremental costs of CNVC traffic, as the TSO should not include fixed and common costs of equipment carrying commercially viable traffic; and

c. the Commission should carefully review the overall allocation of fixed and common costs to TSO traffic in the 03/04 TSO implementation of CostProNZ;

d. the Commission should ensure that changes made to CostProNZ to accommodate a TSLRIC calculation have not been inadvertently carried over to the TSO implementation; and

e. the Commission should ensure that the TSO cost excludes common fixed costs as it is the result of a purely incremental calculation;

538. The Commission considers that the latest version of CostProNZ captures a modelled forward looking network that provides service to the Telecom customer, irrespective of whether TSO or TSLRIC is being discussed.

Network Capital Results sheet of the TransLogic workbook cells C21 and G21

539. Telecom submits[70] that these formulas in the Network Capital Results sheet of the TransLogic workbook cells C21 and G21 should be picking up the Suburban trenching rates in the Calculations sheet but are currently picking up the Urban rates instead.

540. The Commission has accepted Telecom's submission and made the appropriate changes to the model.

Double allocation of structure costs to the Data Network

541. Telecom submits[71] that in the 2002/2003 TSO determination, sharing of the structure costs with the data network was simulated by halving the sharing rates in the tblTRStructureSharing table (see 2002/2003 TSO Determination para A6.17 – A6.20). In the current version of CostProNZ, data traffic has been added so as to model the requirements of the data network and therefore better apportion core costs, including fibre and transmission equipment costs, between the PSTN and FPDN. Given that an appropriate allocation for the data network has now been made, there is no requirement to keep the structure sharing rates in the tblTRStructureSharing table at their reduced values, and the halving should be eliminated.

542. In the current version of CostProNZ, the data network is modelled and costs are appropriately assigned. The updated TSO inputs do not have any assumed data sharing, and are as per the following spreadsheet:

[70] Telecom, *Submission on the TSO 03-04 Draft Determination*, Annex 2, para a2.13, pp. 23 – 24.

[71] Ibid, para b2.13, pp. 24.

Table 56: CostProNZ Sharing Assumptions for Core Network

Forward Looking Sharing Assumption for Core Network

Buried and Underground

sharing component	Dedicated Core Structure	Assumed Average Cables per Access/Core shared structure	Core's portion of Shared Access/Core Structure	Other utility Sharing	Telecom's Portion	Portion of Structure Attributed to Core	CostPro Input to avoid double counting in HCPM and TSO runs
column	*a*	*b*	*c = (1 - a) / b*	*d*	*e = 1 - d*	*f = (e * a) + (e * c)*	*g = e * a*
Metro	[ ]%	[ ]	[ ]%	[ ]%	[ ]%	**[ ]%**	[ ]%
Suburban	[ ]%	[ ]	[ ]%	[ ]%	[ ]%	**[ ]%**	[ ]%
Rural	[ ]%	[ ]	[ ]%	[ ]%	[ ]%	**[ ]%**	[ ]%

Aerial

sharing component	Dedicated Core Structure	Assumed Average Cables per Access/Core shared structure	Core's portion of Shared Access/Core Structure	Other utility Sharing	Telecom's Portion	Portion of Structure Attributed to Core	CostPro Input to avoid double counting in HCPM and TSO runs
column	*A*	*b*	*c = (1 - a) / b*	*D*	*e = 1 - d*	*f = (e * a) + (e * c)*	*g = e * a*
Metro	[ ]%	[ ]	[ ]%	[ ]%	[ ]%	**[ ]%**	[ ]%
Suburban	[ ]%	[ ]	[ ]%	[ ]%	[ ]%	**[ ]%**	[ ]%
Rural	[ ]%	[ ]	[ ]%	[ ]%	[ ]%	**[ ]%**	[ ]%

CCRI and TCNZRI

Submission Sharing Assumptions

543. Telecom has submitted that in relation to Table 56: CostProNZ Sharing Assumptions for Core Network above:

> Telecom also note that the percentage of Dedicated Core Structure in column 'a' for Rural in the structure sharing tables shown in par 701 should be 50%, not 40%, meaning that the CostProNZ input for Telecom's share of Rural Buried and Underground structure should be 42.5%, not 34%, and for Aerial structure should be 30%, not 24%

544. Buried and underground core sharing costs have been set at 40% in response to a Telecom submission[72] which stated that 60% of the core network trenches are shared with the access network. Thus the remainder i.e. 40% of trenches are dedicated.

SDH Regenerator Cost Type Allocation:

545. Telecom submits[73] that in the tblAssetClassification table, SDH Regenerators have been assigned Cost Type "S" (Shared) instead of "D" (Direct). Regenerators are associated with individual transmission rings, not whole fibre paths, i.e., regenerators on a leg of a transmission ring are associated with the SDH systems either side of that leg of that transmission ring. Hence they should be assigned the same Cost Type as SDH systems and SDH Plug In equipment.

546. The Commission considers that if the model is creating a ring, and a regenerator is required, it is not possible to infer whether this is the direct investment of any node on the ring. If however, the regenerator is part of a dedicated spur, even thought the

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[72] Telecom, *Report to the Commission on Modelling of the TSLRIC Toll-Bypass Interconnect Cost*, 31 August 2004, para 33

[73] Telecom, *Submission on the TSO 03-04 Draft Determination*, Annex 2, para c2.13, pp. 24.

regenerator is labelled as "S" (Shared), the model captures it as a Direct ESA investment, so Telecom's suggested change should not be made.

Calculatoin of Usage Related Costs used in the Commission's Radio Models

547. The user of the CostProNZ model identifies the basic nature of each and every asset. That is, by assigning a specific CostType value, the user can identify an assets nature as Directly (D) caused by a cost object, Shared (S) by the demand of multiple cost objects, and Common (C) across all cost objects. A cost object is typically the demand that drives the need for the item of investment. In CostProNZ, there are 3 main Cost Objects: a cluster of customers (a portion of the access network), an ESA, and traffic. Thus, an asset driven Directly by clusters will grow in size over time as the clusters are added (or shrink as clusters are removed).

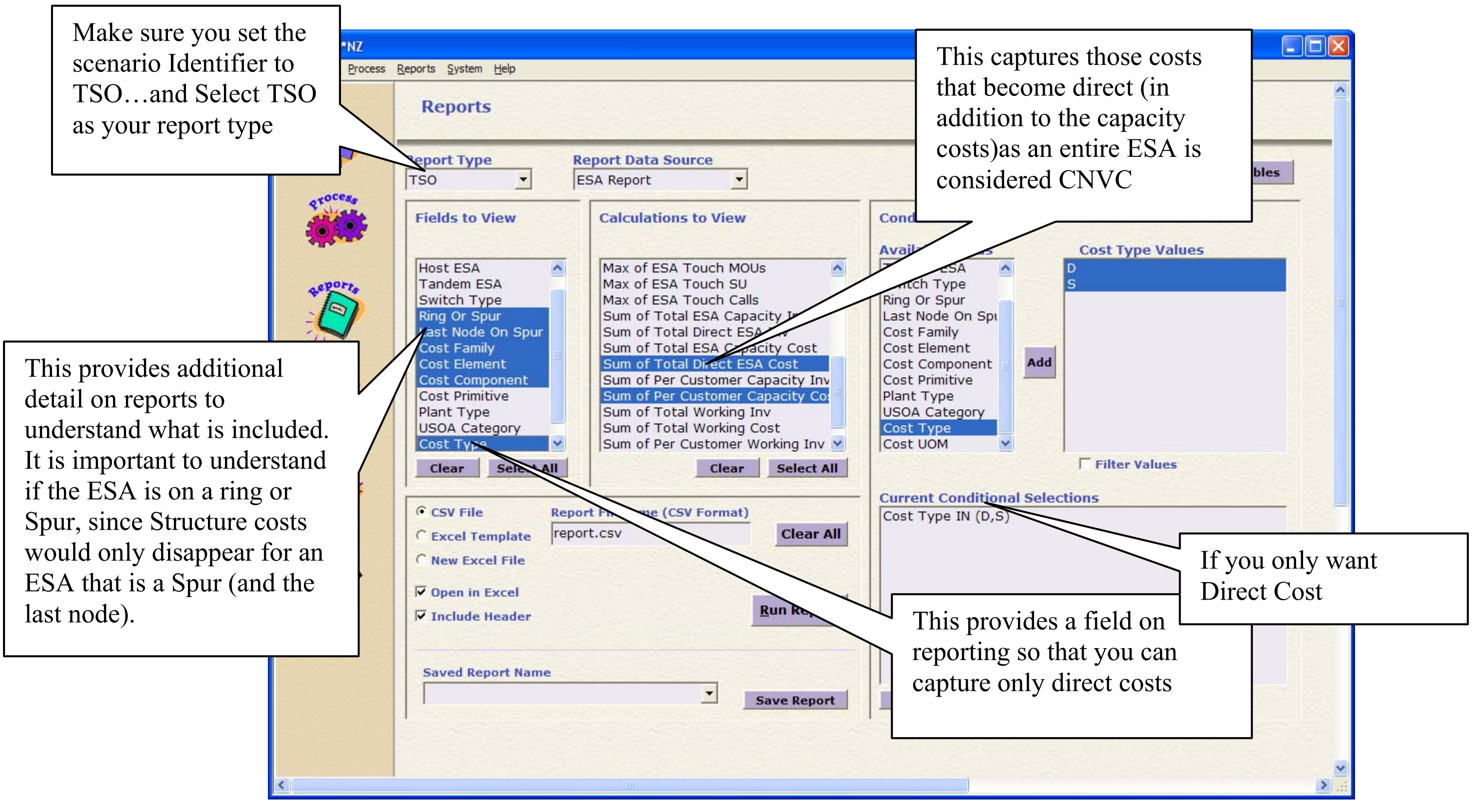
548. In addition to the identification of the CostType, there is spare capacity in the network. That is, as a telecom asset is placed, it typically has more capacity available than is currently needed. For example, a fiber terminal may have capacity for 60 connections. But at any point in time, all 60 will not be used. Even though the fiber terminal may be labelled as a Direct costs, the issue is the nature of the unutilized capacity. Which may be a Shared or a Direct cost. One may view this spare as a shared cost driven by the lumpy (supply comes in big chunks) nature of the network. As such, a decision must be made as to whether to include the Spare cost in a report or exclude it. CostProNZ allows the user to control this by providing both Capacity Cost values and Working Cost Values. The capacity cost represents the long run cost driven by the cost object. The working cost represents the cost of the asset spread over the currently working units (spare capacity is spread).

549. Finally, some Shared costs may become Direct if all the demand of the asset is removed. For example, consider the structure containing the cable that connects an ESA back to another ESA. Also, assume the route is a spur (or dedicated route from the ESA to the parent ESA – not part of ring). For each cluster (or CNVC customer in the cluster) the structure is considered a Shared cost. However, if all clusters are removed (all the customers in an ESA are CNVC), the structure costs now becomes direct.

550. To capture all these cost idiosyncrasies, CostProNZ has been designed to allow the user to control the output provided. As such, the user (at reporting) should:

- Select the CostType to include
  - For TSO, this may only include "D".
- Select either Capacity costs or Working costs
  -For TSO, this may only include "Capacity Costs".
- For those entire ESAs that are CNVC, include the Direct ESA costs
  -This needs to be reviewed on an ESA by ESA basis.

551. Through the proper use of the reporting parameters, the user can then respond to the issues raised in regard to what costs and types of costs are captured. A screen shot of the report now used to calculate backhaul costs follows.



The following screenshot shows the output from the previous report:

[ ] entire screenshot is CCRI.

552. From the report above, it is apparent what costs are Direct (CostType = D) and which cost become direct if an entire ESA is CNVC (only occurs when it is a Ring or Spur for Transport). The report also shows the detail of what is included (e.g., if you only capture Direct costs you can show that building costs are not included).

553. CostQuest has previously provided material discussing economic underpinnings of the CostProNZ model.[74]

554. The Commission considers that the backhaul costs for the Gibson Quai-AAS model, are produced by summing the following from each ESA that was modelled:

Cost Family	Cost Element	Cost Component	Cost Type
Switching	Local	Switch	D
Switching	Tandem	Switch	D
Transport	Host	Electronics	D
Transport	Tandem	Electronics	D
Transport	Remote	Electronics	D

[74] CostQuest, *CostPro*NZ Methodology Manual*, Version 2.0, 28 June 2004, Economics pp9-18

APPENDIX 5: CHATHAM ISLAND ADJUSTMENT

Background

555. Telecom's geo-coded line information did not include customer locations for lines on the Chatham Islands. To estimate the TSO net costs associated with the Chatham Island in a manner consistent with the Commission's overall modelling approach, the Commission has geocoded customer locations on the island over an area approximating the coverage of Telecom's existing cabled network. The resulting files <wtg.in> and <wtg.clu> are included with this release of the HCPM model.

556. The cabled network area includes Waitangi Village, which is the principal centre of population of the island. The total number of lines covered is [ ], split as [ ] first residential (Res1) and [ ] business.

557. Telecom weighted line data reports [ ] Res1 customers served from the Waitangi switch, which leaves a total of [ ] Res1 customers to be served by radio systems. (Note that the HCPM radio cost cap is likely to identify additional radio clusters currently contained in <wtg.clu>.) The lines which fall outside <wtg.clu> are likely to be centred around the smaller remote centres at Owenga, Kaingaroa, Pitt Island etc.

Modelling of Additional Costs

558. In addition to the costs now identified by HCPM, the Chatham island has specific TSO related costs associated with:

- [ ] residential customers served by MAR radio systems;
- Satellite Earth Station equipment required for the spur link to mainland New Zealand; and
- Satellite transponder (capacity) costs.

559. Using the HCPM MAR radio cost cap costing (WACC = 7.4%, 't = 5'), each additional Res1 radio line on the island contributes a TSO net cost equal to the sum of the radio price, the standard operating costs and rural local calling costs minus the Res1 revenue. This equates to a total cost of:

Additional Radio Residential Lines	*$[ ] per annum*

560. Telecom have provided earth station investment and space segment annual costs for the Chatham islands as follows:

Table 57: Chatham Island Cost not Modelled by HCPM

Item	Investment	Residential component	Annualisation based on CostProNZ Radio	Annualised Cost
Equip @ WTG	$[ ]		[ ]	$[ ]
Equip @ WW	$[ ]		[ ]	$[ ]
Annual Space Segment Fee	$[ ]	[ ]		$[ ]
Total				$[ ]]

561. Annual costs are calculated using the annualisation factor for radio equipment from the CostProNZ model. Capacity costs associated with the 30 channel space segment are split based on the proportion of residential traffic to business traffic on the link

562. The additional (i.e. not calculated using HCPM) annual TSO net cost associated with serving the Chatham Island is therefore calculated as:

Table 58: Total Chatham Islands Adjustment

Factor	Per Annum Cost
Radio Lines	$[ ] CCRI
Earth Station and Space Segment	$[ ] CCRI
Total Adjustment	$762,896

APPENDIX 6: COMMISSION NET COST CALCULATION METHODOLOGY

563. HCPM is a forward-looking economic, computer based cost model which is used by regulatory authorities to estimate the forward-looking costs of network facilities and services. The model, as used in the United States, and associated documentation is publicly available for download from the FCC's web site:

    http://www.fcc.gov/wcb/tapd/hcpm/welcome.html

564. The model was introduced to industry by Commission and FCC staff during the Commission's TSO Modelling Workshop, November 12, 2002. This model takes an approach which:
    - is consistent with the Commission's bottom-up, scorched-node modelling position;
    - can be adapted to calculate TSO net cost as required by the Act;
    - is transparent;
    - can be supported and validated by international experts in a cost effective manner; and
    - is well known to the industry both in New Zealand and overseas.

565. The model was originally developed by the FCC as an alternative to models being promoted by US industry players for various regulatory purposes, including the calculation of Universal Service Obligation (USO) levies. In its standard form, the model performs engineering design and costing for both the local loop and switching/transport networks, using economic cost minimisation principles.

566. The switching/transport module supplied with the standard HCPM package is an older version of the Hatfield (HAI) model configured for US network conditions. The Commission determined that adaptation and verification of this switching model for Commission purposes was likely to be less cost effective than development of the CostProNZ model. For the Commission's purposes, only the access components of HCPM are utilised.

567. The HCPM access model consists of two independent modules – a customer location module and a loop design module.
    1. <u>The Customer Location Module</u> (cluster.exe) uses geo-coded customer location and demand information for an ESA (exchange) in the form of an <ESAname.in> file and groups customer locations into clusters, using engineering design rules, to form distribution cabinet areas. The output is a cluster file <ESAname.clu>.
    2. <u>Loop Design Algorithms</u> (clusintf.exe and feeddist.exe). Clusintf computes cluster customer density information to be used in the network design and converts <ESAname.clu> files into binary files for feeddist. Feeddist designs and costs distribution network and feeder network plant for the ESA.

568. The loop design module determines the total investment required for an optimal distribution and feeder network by building access network plant to the designated customer locations. Details of the design process are contained in the HCPM documentation on the Commerce Commission website 'Computer Modelling of the

Local Telephone Network October 1999', http://www.comcom.govt.nz/IndustryRegulation/Telecommunications/TelecommunicationsServiceObligations/ContentFiles/Documents/Commerce%20Commission%20TSO%20Model%20Documentation%20-%20Appendix,%2023%20April%2020030.pdf

569. For use in some US regulatory applications, HCPM has the facility to use a proxy for real customer location and demand information, based on Census Block customer densities and demand forecasts. This feature is not used in New Zealand.

570. The HCPM modules are written in high level programming languages, and compiled versions can be supported on a number of computing environments, including standard desktop PCs.

Adaptation of HCPM to New Zealand Regulatory Requirements

571. Adaptation of HCPM for the purposes of determining TSO net cost comprises:

- processing of geo-coded customer location and terrain information into clusters based on pre-determined engineering rules;
- determination of the status of clusters as viable or non-viable based on their incremental costs and revenues (with the exception of areas for which the Wireless Technology Cost Cap has been exceeded); and
- calculation of the overall net cost of the TSO arising from commercially non-viable wire-line and wireless areas.

572. The first step in the process is the creation of clusters and their storage as a set of <ESAname.clu> files which represent the whole network.

573. Service demand and customer location information, geographically separated into ESAs, has been supplied to the Commission by Telecom.

574. The model operates with 783 ESAs, which mostly correspond to historical nodes in Telecom's network. Of these, [ ] TCNZRI currently house 'nodes' which may be NEAX 61E switch/RLU or older type NEC technology. Without rationalisation of some very small switching nodes, this identifies [ ] TCNZRI 'switchless' ESAs which require to be connected via feeder technology to the nearest appropriate host node site.

575. The rationalisation of small nodes, assignment of host nodes for switchless ESAs and the design of the (sometimes lengthy) switchless ESA feeder links is performed by the CostProNZ switching and transport model.

576. The Cluster processing phase is illustrated in Figure 10: Cluster Processing below:

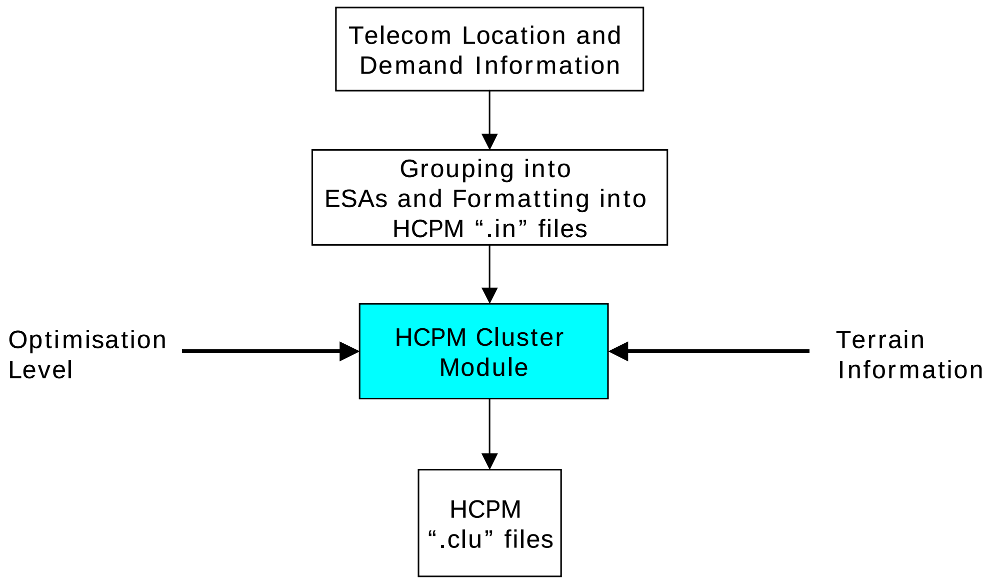


Figure 10: Cluster Processing

577. In addition to the set of <ESAname.in> customer location and demand information files, the HCPM clustering process requires the operator to set the level and type of cluster optimisation and to determine a range of geographical terrain settings for each cluster.

578. HCPM network design optimisation utilises a Minimum Spanning Tree algorithm (Prim Algorithm) developed for the purposes of finding the shortest connection network for linking a number of known points.

579. HCPM always applies the Prim Algorithm for feeder network design and may optionally apply it in the design of distribution networks within each cluster. The optimisation has the greatest impact for clusters which have low customer densities, where the distribution network most resembles a feeder network layout.

580. HCPM Terrain Information for each cluster has been derived from ESA cable laying difficulty analyses supplied by Telecom.

581. The set of <ESAname.clu> files, produced by clustering, can be used directly to generate capital and expensed costs for each ESA as illustrated in Figure 11: HCPM Costing Process below.

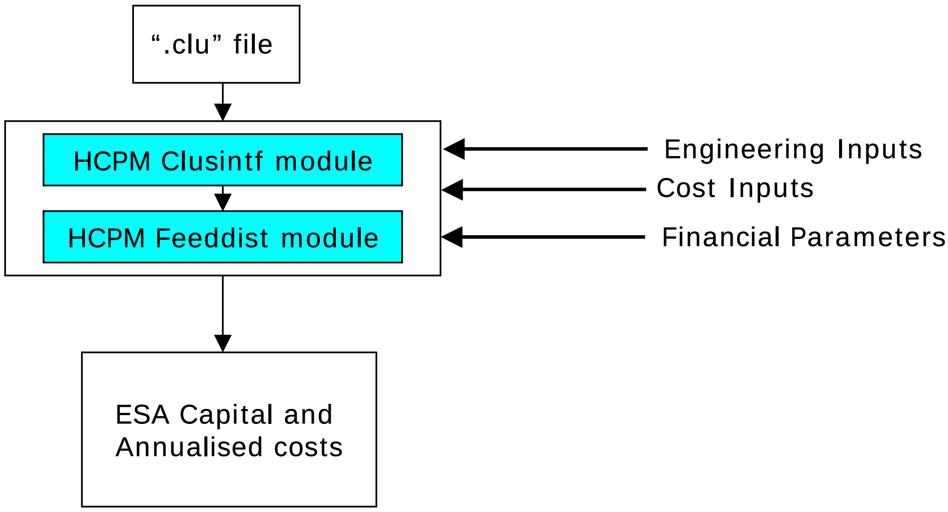


Figure 11: HCPM Costing Process

582. The basic costing process requires a range of engineering, cost and financial inputs. The inputs used by the Commission have been developed following industry consultation and are included in 'Appendix 1: TSO Model Inputs, Updates and Changes'.

583. HCPM creates a number of reports on the optimised network design. These are in the form of '*.csv' files in the 'c:\hcpm' directory. The reports include annualised costs of clusters and their component parts in 'EXPENSE.CSV'.

584. Although individual cluster expenses are available directly from this file, HCPM performs an allocation of feeder costs to each cluster which, in some cases, may over or understate the incremental cost of that cluster.

585. The Commission's methodology for implementing the first stage of TSO radio cap is to examine the cluster expenses recorded in EXPENSE.CSV and apply the cap if cost per line exceeds the cap. The radio cap covers both the cost of feeder and distribution for the cluster. The radio cap is not applied at this stage for high cost clusters which have more than 50 lines and feeder costs which exceed 60% of the total cluster cost. This avoids using expensive radio systems for clusters which have been allocated feeder costs that are more properly incremental on remote clusters which share feeder infrastructure with the cluster being examined.

586. Consequently, remote clusters may report low costs in EXPENSE.CSV and not be identified by the radio cap process. For this reason, a second radio cap test is applied during the initial costing of wired clusters.

587. Radio clusters are removed from the '*.clu' files before wired costing begins.

588. The process for calculating the incremental costs of wired clusters, checking for viability and collecting the net cost associated with non-viable clusters is illustrated in Figure 12: Cost Calculation Process below.

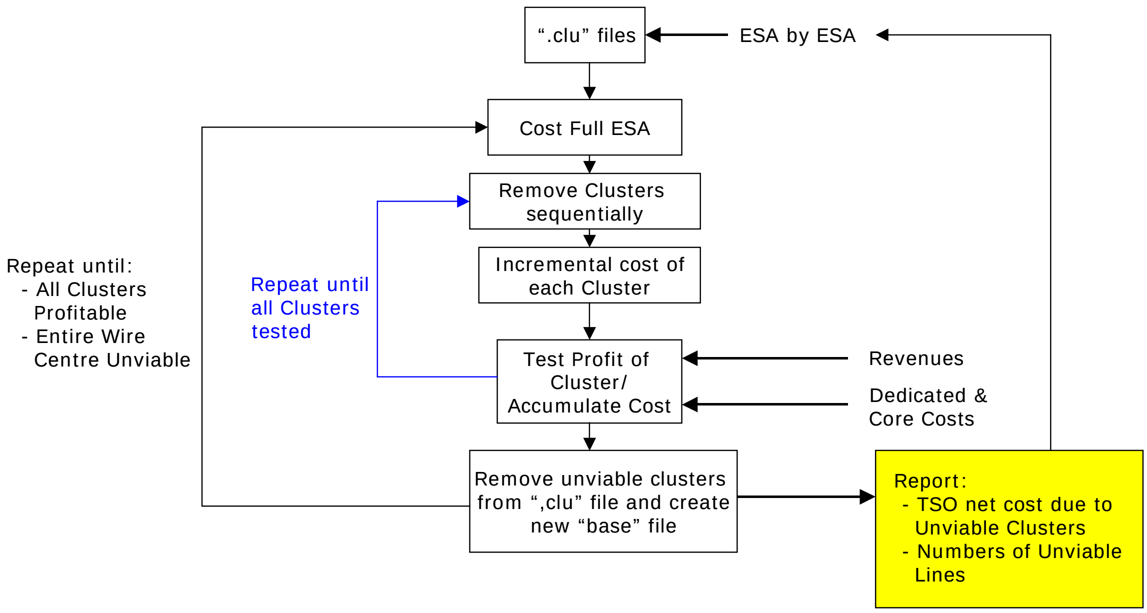


Figure 12: Cost Calculation Process

589. The incremental cost of an individual wired cluster is calculated by comparing the costs calculated for the full ESA with the costs calculated for the ESA with that cluster removed.

590. The clusters are removed by automatically identifying the clusters within an ESA and editing the <ESAname.clu> file to remove each one in turn. The incremental cost identified is the difference between the full cost of the ESA and the cost determined by passing the edited '.clu' file through the HCPM design and costing modules. It should be noted that HCPM designs a new ESA network based on the modified '.clu' file. The costs being compared are, therefore, those of the full ESA and those of the ESA re-designed to remove the costs associated with the cluster being tested.

591. The viability of a cluster is tested by comparing its access network costs (determined by HCPM, or by the second application of the radio cap process if HCPM costs now exceed the radio threshold) with its allowable direct and indirect revenues. Revenues for Residential and Business customers in each ESA are determined from information provided by Telecom. The process for calculating the average revenue per line is described in Appendices 1 and 4 and the Model Input section of the 2002/2003 TSO Determination.

592. A single pass through all of the clusters in an ESA could identify a number of viable and non-viable serving areas. The single pass, however, is not sufficient to identify if some apparently viable areas are dependent on economies of scale provided by surrounding non-viable clusters. For example, Figure 13 below is the scenario of a viable cluster (number 3) which shares a feeder route with 2 non-viable clusters (numbers 2 and 4).

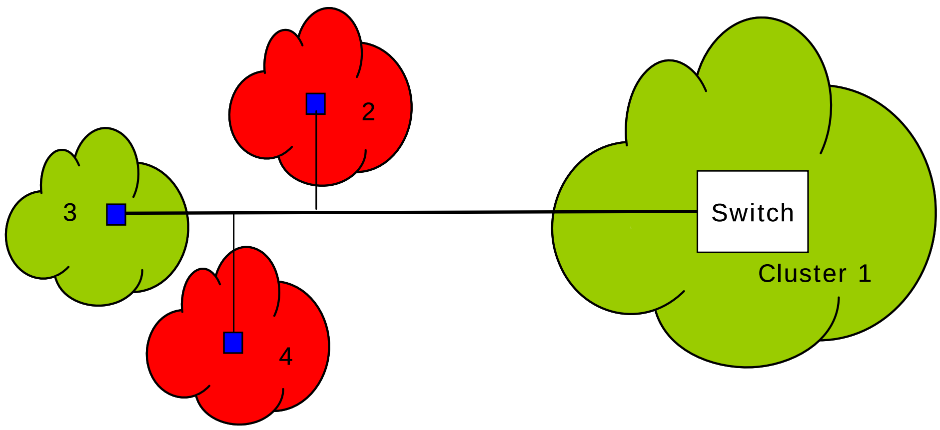


Figure 13: Cluster Scenario

Cluster Scenario

593. In this case, the first pass through the clusters has identified two viable and two non-viable areas. It is clear however, that the incremental cost tested for cluster 3 may include only its dedicated distribution infrastructure, a small amount of dedicated feeder infrastructure and a share of feeder cabling with clusters 2 and 4. Cluster 3 must be re-tested to determine its viability in the case that clusters 2 and 4 were not served.

594. The model performs this test by iterating the incremental cost analysis. The steps are:

- create a new 'base' ESA cluster file including only the clusters identified as viable on the fist pass;
- re-test the incremental costs of all clusters; and
- repeat iteration process if further clusters have proven non-viable.

595. Iteration finishes when all remaining clusters remain viable on iteration, or when all clusters have proven non-viable, in which case the entire ESA is non-viable. When a result is achieved for an ESA, the process moves on to the next ESA, accumulating a net cost for the entire network.

596. For the scenario illustrated above Figure 13: Cluster Scenario, cluster 3 may be able to cover the full costs of the re-designed feeder network (without clusters 2 and 4) or may become non-viable when loaded with the additional costs. If cluster 3 proves non viable, then its net cost is added to that accumulated for clusters 2 and 4.

597. In cases where all of the clusters in an ESA have proven incrementally non-viable, the model re-tests cluster 1 as a stand-alone network, which may prove viable after having removed all costs associated with feeder networks serving other clusters.

598. In some instances, the incremental cost process developed around HCPM may treat some costs as fixed, which should arguably be incremental to a group of clusters. For example, the figure below Figure 14: Incremental Cost Scenario shows a modification of the above scenario Figure 13: Cluster Scenario, where two incrementally viable clusters share a significant fixed feeder investment.

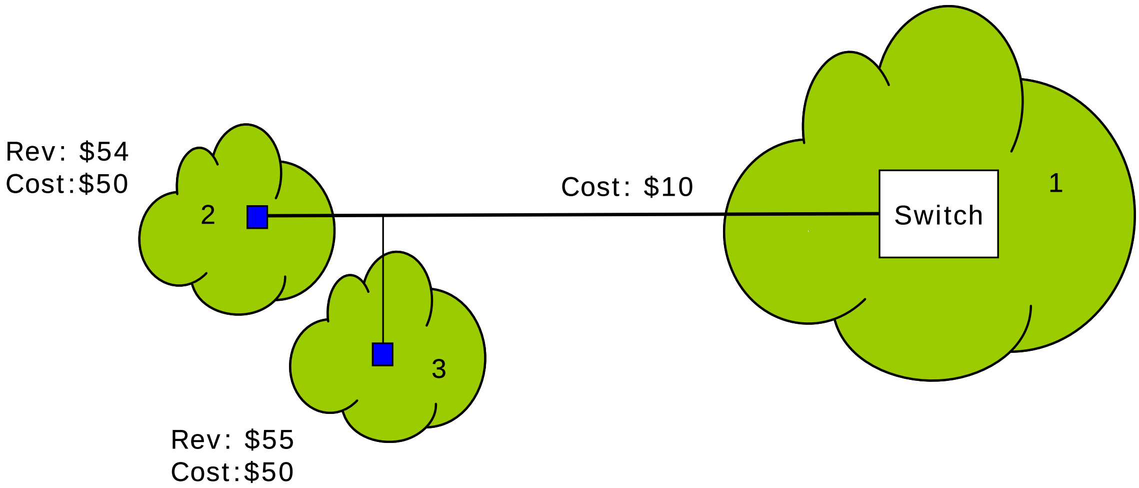


Figure 14: Incremental Cost Scenario

Incremental Cost Scenario

599. Individually removing clusters 2 and 3 above and testing for viability, shows each to be profitable with cluster 2 revenues exceeding cost by $4 and cluster 3 by $5. However, looking at the entire feeder segment with two clusters shows a total cost of $110, which exceeds the combined revenues of $109. This scenario could occur within an ESA, but is not normally observed as remote/low density rural clusters seldom cover the economic costs of their distribution networks. The radio cap process correctly identifies feeder costs associated with such clusters.

600. A similar situation may occur when clusters 2 and 3 in Figure 14: Incremental Cost Scenario are independently non-viable. (e.g. when both sets of revenue are reduced to less than $50). These clusters would both be removed on the first iteration, leaving a hanging network cost of $10, which would not be identified as variable unless the entire ESA became non-viable. For this reason, the model identifies 'hanging' costs associated with the removal of non-viable clusters by testing the costs of removed clusters against the original ESA cost and the viable network costs remaining after iteration. Any identified hanging network costs are added to the TSO cost accumulation.

601. To prevent the inclusion of costs associated with non-viable business customers, the model is set to test the viability of business lines within a non-viable cluster to determine whether their average income exceeds the average cost per line within the cluster. If average business costs exceed revenues, both the revenues and costs attributable to business lines are removed from the calculation of net cost.

Accumulation of CostProNZ Direct ESA costs

602. When the TSO cost calculation methodology identifies that the entire wired portion of an ESA has become non-viable, the full HCPM wired ESA annual cost plus the CostProNZ Direct cost for that ESA is accumulated into the TSO net cost (assuming there are no profitable radio clusters).

603. Different basis for optimisation could have been selected. These could have included how a efficient service provider in the position of the TSP might have:

- contracted out the TSO; and
- planned the deployment of technology to meet its TSO obligations.

604. The Commission has chosen to model the latter and thus the modelling has been based on cluster viability.

605. The Commission notes that Telecom increasingly provides service across ESA boundaries, combines radio infrastructure for rural ESAs and intends to break the ESA structure completely with migration to NGN.

606. The modelling considers the extent that the current core network is optimised in serving the needs of the current cluster base. There is a requirement to model existing behaviour (e.g. calling patterns) and it was decided to largely accept the reality of the TSP's transport network. It was realised that the design could have been manipulated to either increase or decrease the cost. e.g. a feeder to CNV exchange could carry viable traffic, this might have happened if the ESA's boundaries had changed.

607. Cluster 'number 1' is the base cluster of each ESA – it is generally an 'in-town' cluster and will probably have at least one business customer. Given that it has one business customer sharing the common line it is not a TSO cost.

HCPM Model Inputs

The HCPM Model Inputs and discussions of their derivation are contained in 'Appendix 1: TSO Model Inputs, Updates and Changes'.

APPENDIX 7: TSO MODEL REVENUE INPUTS

Background

608. HCPM and CostProNZ cost modelling determines the viability of clusters of lines through comparison of efficient costs with average revenues derived from Telecom's revenue information for the relevant TSO period.

609. The base revenue information is provided on a quarterly basis and is categorised as follows:

    - Line and supplementary service revenue for residential first line customers (Res1)
    - Line and supplementary service revenue for residential second and subsequent line customers (Res2)
    - Line and supplementary service revenue for residential lines on per call payment plans (ResPay)
    - Business Customers (Bus)

Revenue Analysis

610. For the purposes of determining the TSO net cost, only residential first line (Res1) costs may contribute. For this reason, all other residential lines are treated as business lines in the modelling. This ensures that loss making residential second or special plan lines do not contribute to the TSO net cost.

611. Practically, HCPM input files <***.clu> have been adjusted to ensure that the geocoded residential locations report only one residential line. Second and subsequent lines are converted to business lines at the same location. Note that multi tenanted locations have multiple location entries (at the same geo-located point) in the input files.

612. Res1 revenues are calculated as the standard line rental for the period plus the applicable supplementary revenues:

    - National and international toll calling, smart-phone services
    - Calling to and from mobile networks
    - Incoming revenues due to business local calling and residential/business national calling into the ESA.

613. Some relevant costs associated with this revenue are not calculated directly by the HCPM or CostProNZ models. Specifically these are:

    - Interconnect charges, including fixed to mobile (Vodafone)
    - Fixed to mobile termination costs (Telecom Mobile)
    - Incoming call costs

614. Interconnect charges are sourced directly from Telecom's reported revenue and call volume data.[75] Incoming call costs are calculated using reported call volumes, and per minute call charges calculated using the CostProNZ model:

[75] Fixed to mobile termination costs have been modelled by Telecom and supplied to the Commission. The Telecom figure of [ ] TCNZRI cents per minute is an estimate of the incremental cost of terminating a call on

615. Business revenues are calculated as a summation of Bus, Res2 and ResPay, using the additional cost modelling described for Res1.

Telecom's Reporting of Their Revenue Information

616. Telecom, as part of the preparation for the TSO supplies annual data including traffic and revenue information. This information has been supplied in advance of the relevant draft determination to the Liable Persons who have identified a number improvement opportunities for Telecom's documentation. Telecom has had an opportunity to respond to these improvement opportunities.

617. The raw revenue information is now provide as part of the TSO information. In addition liable persons comment and Telecom's response to these comments are attached as part of the models documentation.

the Telecom mobile network. According to Telecom, this is not a TSLRIC estimate but one made in the context of the TSO net cost calculation.

APPENDIX 8: SQM 11.1 A & B

618. The Telecommunications Service Obligations (TSO) Deed for Local Residential Telephone Service was agreed on December 2001. A key part of the deed is the Specific Quality Measures (SQM) that are an agreed minimum performance metric.

619. The Deed has eight SQM:

11.1 Line connect capacity for standard Internet Calls
11.2 Additional connect speed measures
11.3 Unsuccessful standard residential call attempts that under normal conditions cannot terminate as a percent of total stand residential call attempts
11.4 Unsuccessful standard Internet call attempts that under normal conditions cannot terminate as a percent of total stand residential call attempts
11.5 Whole minutes of Telecom complete switch downtime for standard residential calls
11.6 111 calls that under normal conditions are answered by the 111 National Service Centre within 15 seconds
11.7 Whole minutes of complete 111 National Service Centre downtime that arise from reconfigurations in the Telecom's network.
11.8 Whole minutes of complete 111 National Service Centre downtime that do not arise from reconfiguration in Telecom's network.

620. In principle there are two ways that statistics can be compiled. They are either as a census, which has no sampling errors, or as a sample, which has defined statistical properties normally expressed as a mean plus a confidence interval for the mean.

621. Each SQM with the exception of 11.1 can be measured directly or in sufficiently large numbers so that there is an arbitrarily small sampling error with a correspondingly small confidence interval.

622. SQM 11.1 is unable to be measured directly from Telecom's billing and network management equipment.

623. SQM 11.1 states:

> 11.1 Line connect speed capacity for standard Internet calls
>
> The measures (which apply for standard Internet calls from and after the second anniversary of the commencement date) are:
>
> (a) 95% of all existing residential lines meet the 14.4pks(sic) connect speed;
>
> (b) 99% of all existing residential lines meet the 9.6kps (sic) connect speed.
>
> For the purposes of assessing Telecom's performance against these measures:
>
> (c) an inability for an existing residential line to reach the kps (sic) connect speed measure arising from an event of force majeure or a specified matter beyond Telecom's reasonable control is to be disregarded;
>
> (d) the measurement will consist of the application of a calibrated model to the installed local access plant records held by Telecom

624. SQM 11.1 is to be measured by a 'calibrated' model. The Commission used a statistically valid calibrated model based on randomly sampling those lines that were connected at the time that the TSO Deed was signed.

625. Telecom selected a stratified random sample of 1000 phone lines, allocating the sample across seven technology types. The stratified sample design was chosen since there is an expectation that the line speeds vary by technology type.

626. There are seven different technology types: 0+2; CMAR; CMAR-2M; Copper; Country Set; PCM; and Siescor.

627. The allocation of the sample is proportional to stratum size. This led to two technology types (Country Set and Siescor) having no sample allocated and hence no chance of selection. The estimates that Telecom eventually provided do not apply to lines of these two types, since they had no chance of inclusion in the sample. Other technology types 0+2; CMAR and CMAR-2M have very low sample sizes.

Sampling Methodology

628. The following sampling methodology was employed in evaluating SQM11.1:

- Allocate each of the lines that was in service in December 2001 to a unique technology class in a database;
- Allocate a random number to each record in the database;
- Sort by this random number;
- Take the first 'n' records from each technology class, where n is the desired sample size for that technology type.

Replacement Samples

629. Replacement samples are normally drawn so that in the eventuality that a sample cannot be obtained such as may happen if the line no longer exists or if the customer would not cooperate and allow a line measurement to be taken then a substitution is possible. No replacement samples were drawn.

Analysis

630. The Commission acceptance criterion is that the relevant tests are statistically significant using a 95% confidence interval.

APPENDIX 9: ESA ABBREVIATIONS

631. Exchange Service Areas ("ESA") are the fundamental geographic unit that the TSO is based around. There are 786 ESAs. Each ESA is given an abbreviation. The full names of the ESA are shown in this appendix.

ESA	Esa Name	ESA	Esa Name	ESA	Esa Name	ESA	Esa Name
AAI	Awanui	CE	Clive	GDW	Glendowie	HYD	Hyde
ABB	Andersons Bay	CH	Christchurch	GG	Gore	IBY	Island Bay
ABY	Albury	CI	Carterton	GG1	Gore 1	ID	Inglewood
AH	Ashhurst	CL	Coromandel	GID	Green Island	IN	Invercargill
AHA	Ataahua	CLB	Clarence Bridge	GL	Glenavy	INE	Invercargill East
AHI	Ahitit	CLE	Claudelands	GLB	Glenbrook	INJ	Inangahua Junction
AHP	Arthurs Pass	CLV	Colville	GLE	Glen Eden	IRW	Irwell
AIA	Aria	CMW	Cromwell	GLF	Glenfield	ISL	Islington
AKCE	Auckland	CO	Clinton	GLS	Gladstone	JFK	John F Kennedy Dr.
AL	Alexandra	COL	Colyton	GLT	Gleniti	JV	Johnsonville
ALF	Alfredton	CPC	Courtenay Place	GLU	Glentunnel	KA	Karaka
ALY	Albany	CT	Cheviot	GLY	Glenroy	KAA	Kaiaua
AO	Akaroa	CTE	Corstorphine	GM	Greymouth	KAM	Kamo
AO1	Akaroa1	CTP	Canturbury Tech Park	GMY	Glen Murray	KAN	Kairanga
AON	Aongatete	CU	Cust	GN	Greytown	KAO	Kaeo
AP	Apiti	CVD	Culverden	GNH	Greenhithe	KAP	Kapuka
APA	Ahipara	CVE	Cloverlea	GNO	Glen Oroua	KAU	Kawau Island
AR	Ashburton	CW	Collingwood	GOR	Gordonton	KC	Kerikeri
ARD	Arundel	CY	Chertsey	GOV	Governors Bay	KEN	Kennington
ARU	Auroa	CYD	Clyde	GPK	Greenpark	KEU	Kawerau
ASC	Ashley Clinton	DA	Devonport	GS	Gisborne	KF	Kaipara Flats
ATM	Atiamuri	DB	Duvauchelle	GTN	Garston	KFR	Kaingaroa Forest
ATN	Alicetown	DBK	Dunback	GV	Gonville	KG	Kekerengu
AU	Ahaura	DHB	Diamond Harbour	HA	Hampden	KGR	Kelvin Grove
AVD	Avondale	DIP	Dipton	HAG	Hangaroa	KHA	Kaharoa
AVO	Avonhead	DMD	Drummond	HAL	Halcombe	KHO	Kaikohe
AW	Arrowtown	DN	Dunedin	HAS	Haast	KHO1	Kaikohe 1
AWF	Ashwick Flat	DOB	Dobson	HAW	Hawarden	KI	Kaiapoi
AWI	Atawhai	DOR	Dorie	HBC	Hibiscus Coast	KIL	Kilbirnie
AWU	Awhitu	DRF	Darfield	HBN	Hastings	KIM	Kimbolton
AY	Amberley	DRF1	Darfield 1	HBN1	Hastings 1	KIN	Kirikopuni
BAL	Balfour	DRL	Dargaville	HCK	Howick	KIO	Kiokio
BBK	Bell Block	DS	Douglas	HDS	Hinds	KIW	Kiwitahi
BD	Birkenhead	DSD	Dunsandel	HFB	Halfway Bush	KK	Kaikoura
BDE	Benneydale	DUN	Duntroon	HG	Hikurangi	KKT	Kakatahi
BEA	Beachlands	DUR	Dunrobin	HGH	Hedgehope	KLB	Kelburn
BEL	Belfast	DV	Dannevirke	HIG	Highbank	KM	Karamea
BGN	Brighton	EDD	Edendale	HIL	Hilton	KME	Kumeu
BGW	Brightwater	EDG	Edgecumbe	HIM	Himatangi	KNA	Kaitangata
BHB	Blockhouse Bay	EE	Eastbourne	HIN	Hinuera	KNG	Kensington
BHE	Bethlehem	EGV	Egmont Village	HIT	Hilderthorpe	KNH	Khandallah
BHN	Burnham	EKA	Eketahuna	HK	Hokitika	KOU	Kohukohu
BID	Bideford	ELL	Ellerslie	HKA	Hikutaia	KOW	Kurow
BKL	Birkdale	ELP	Elsthorpe	HKO	Herekino	KP	Kaka Point
BKM	Beckenham	ELS	Elstow	HL	Helensville	KPA	Kaukapakapa
BL	Balclutha	ELT	Eltham	HLY	Huntly	KPE	Kerepehi
BLF	Bluff	ENF	Enfield	HMB	Halfmoon Bay	KPO	Kaponga
BLI	Blairlogie	ETM	East Tamaki	HMN	Haumoana	KRI	Karori
BM	Blenheim	EUR	Eureka	HN	Hamilton	KT	Katikati
BM1	Blenhiem 1	FB	Foxton Beach	HNE	Hamilton East	KTA	Kaitaia
BM2	Blenhiem 2	FDL	Fordell	HO	Hororata	KTI	Kaiteriteri
BMT	Belmont	FDN	Fendalton	HOI	Hoi-O-Tainui	KUA	Kumara
BN	Browns	FG	Feilding	HOT	Horotiu	KV	Kawakawa
BOB	Bombay	FGF	Flagstaff	HP	Hanmer Springs	KW	Kai Iwi
BRW	Broadwood	FJG	Franz Josef Glacier	HR	Huia	KWA	Kawhia
BS	Bulls	FJN	Frankton	HRD	Harewood	KWI	Kirwee
BSK	Brunswick	FK	Fairlie	HRI	Harihari	KWK	Kaiwaka
BSY	Browns Bay	FLH	Frankleigh Park	HRT	Heriot	LAW	Lawrence
BTN	Barrytown	FME	Flaxmere	HSD	Horsham Downs	LBN	Loburn
BUN	Bunnythorpe	FN	Featherston	HSL	Halswell	LCN	Lincoln
BUR	Burwood	FOR	Forrest Hill	HSN	Henderson	LCR	Lake Coleridge
BV	Bay View	FP	French Pass	HTI	Hataitai	LEI	Leith Valley
BYM	Brymer	FX	Foxton	HTN	Hillmorton	LEP	Lepperton
CAM	Cheltenham	FXR	Fox Glacier	HUN	Hunua	LH	Leigh
CAV	Cave	GAL	Galatea	HV	Havelock	LHT	Lower Hutt
CB	Cambridge	GBI	Great Barrier Island	HVL	Hunterville	LIN	Linwood
CD	Clevedon	GC	Granity	HVN	Havelock North	LLD	Lichfield
CDV	Clydevale	GD	Geraldine	HW	Hawera	LMC	Linton Milatry Camp

ESA	Esa Name	ESA	Esa Name	ESA	Esa Name	ESA	Esa Name
LMO	Lower Moutere	MRE	Mangere	OKR	Oakura	POH	Pohangina
LMS	Lumsden	MRI	Makuri	OMI	Omihi	POP	Papatoetoe
LOB	Lochmara	MRN	Morven	OMK	Omakere	POW	Port Waikato
LRV	Little River	MRP	Mt Ruapehu	OMM	Omarama	POY	Ponsonby
LSN	Leeston	MRT	Mataroa	OMO	Omokoroa	PPM	Paparimu
LTK	Lake Tekapo	MS	Masterton	OMT	Otematata	PRM	Paraparaumu
LTN	Linton	MSI	Mosgiel	OMU	Omakau	PRO	Porirua
LVN	Levin	MSM	Mt Somers	ON	Onehunga	PTA	Patearoa
LYE	Lynmore	MSY	Massey	ONG	Ohingaiti	PTE	Patetonga
LYN	Lytton West	MT	Mataura	ONH	Onewhero	PTN	Petone
LYT	Lyttelton	MTA	Matata	OOK	Okawa	PTO	Patoka
MA	Manaia	MTG	Matangi	OP	Opotiki	PTS	Picton Sounds
MAB	Mt Albert	MTK	Matakana	OPA	Opito Bay	PTU	Pukeatua
MAE	Manawahae	MTL	Mt Roskill	OPK	Opiki	PUA	Puahue
MAG	Mangamahu	MTM	Motu	OPN	Opononi	PUE	Puketurua
MAK	Makikihi	MTP	Mangatangi	OR	Ohura	PUH	Puhoi
MAM	Matamata	MTW	Matiere	ORA	Outram	PUI	Papanui
MAN	Maungati	MU	Motueka	ORH	Onerahi	PUK	Pukekohe
MAO	Maraetotara	MUP	Murupara	ORM	Ormond	PUT	Putaruru
MAT	Murchison	MUS	Manutuke South	ORN	Orini	PW	Pukekawa
MAU	Maungaturoto	MV	Mauriceville	ORP	Orepuki	PWA	Parawera
MAW	Marewa	MVE	Melville	OT	Otaki	QST	Queenstown
MBA	Martinborough	MVN	Methven	OTE	Otumoetai	RAG	Raglan
MBB	Macandrew Bay	MWD	Matawai	OTN	Otane	RAI	Rai Valley
MCF	Macraes Flat	MWI	Mangawhai	OTO	Okato	RAK	Rakaia
MCK	Mt Cook	MWN	Mt Wellington	OTR	Otatara	RAM	Raumati
MDL	Middlemarch	MX	Maxwell	OTU	Otipua	RBH	Ryal Bush
MDX	Middleton	MXL	Maxwells Line	OTW	Otewa	RCK	Renwick
MFD	Mayfield	NA	Napier	OU	Oamaru	RCM	Runciman
MFL	Millers Flat	NAE	Naenae	OUN	Oamaru North	RD	Richmond
MG	Maungatautari	NAT	National Park	OV	Ormondville	RDB	Red Beach
MGA	Mangaweka	NB	Normanby	OW	Ohaeawai	REO	Reporoa
MGI	Mangonui	NBO	New Brighton	OWI	Orawia	RET	Raetihi
MGK	Maungakaramea	NE	Ngahere	OWN	Owhango	REW	Rerewhakaaitu
MGL	Mangakahia	NG	Ngunguru	OX	Oxford	RGT	Rangitaiki
MH	Mahia	NGB	Ngatapa	PA	Patea	RGW	Rangiwahia
MHG	Mahurangi	NGC	Nightcaps	PAE	Paekakariki	RHU	Rahotu
MHL	Maori Hill	NGI	Ngatimoti	PAK	Papakura	RI	Riverton
MHO	Maheno	NGT	Ngatea	PAN	Parnassus	RIC	Riccarton
MI	Milton	NGU	Ngarua	PAP	Paparoa	RKW	Ruakawakawa
MIA	Maruia	NHI	Ngahinapouri	PAR	Paroa	RL	Russell
MID	Midhurst	NK	Nuhaka	PAU	Pukerau	RN	Reefton
MIH	Maihiihi	NLN	New Lynn	PBL	Peebles	RNF	Ranfurly
MIK	Makirikiri	NN	Nelson	PBO	Portobello	RNF1	Ranfurly 1
MIR	Miramar	NOA	Ngongotaha	PC	Port Chalmers	RNU	Rangiotu
MKE	Manutuke	NOM	Ngaroma	PCV	Pacific View	RO	Rotorua
MKJ	Mkj	NR	Ngakuru	PE	Pukehina	ROG	Rotongaro
MKK	Maraekakaho	NRN	Netherton	PEG	Paengaroa	ROI	Rotoiti
MKN	Mokihinui	NT	Ngaruawahia	PER	Peria	ROL	Rolleston
MKO	Mangakino	NU	New Plymouth	PGA	Pakuranga	ROM	Rotoma
MKT	Maketu	NVY	North East Valley	PGB	Pigeon Bay	RON	Rongotea
MKW	Makarewa	NWD	Norsewood	PH	Porangahau	ROO	Rotoorangi
MKY	Manukau City	OAA	Otara	PHA	Pahiatua	ROW	Rotowaro
ML	Marton	OAG	Onga Onga	PHA1	Pahiatua 1	RPG	Raupunga
MMA	Memorial Ave	OAH	Okaihau	PHI	Patutahi	RR	Rangiora
MMK	Mamaku	OAK	Owaka	PHO	Patumahoe	RS	Ross
MMN	Mt Maunganui	OAR	Otamauri	PIA	Piha	RSB	Ravensbourne
MMR	Maramarua	OAU	Otautau	PIH	Paihia	RSN	Rissington
MN	Manutahi	OAU1	Otautau 1	PIN	Pirinoa	RTG	Ruatangata
MNA	Moana	OEA	Oturehua	PIO	Piopio	RUE	Remuera
MNG	Mornington	OF	Okere Falls	PIR	Pirongia	RUK	Ruakaka
MNK	Manakau	OGU	Ongarue	PK	Pokeno	RUN	Runanga
MNR	Manurewa	OH	Otahuhu	PKB	Pukerua Bay	RUT	Ruatoria
MNW	Manawaru	OHA	Otorohanga	PL	Palmerston	RUW	Ruawai
MOA	Mokau (Ahititi)	OHE	Ohope	PLB	Palliser Bay	RVD	Riversdale
MOB	Mossburn	OHG	Ohangai	PLM	Plimmerton	RWN	Rawene
MOD	Mt Eden	OHK	Ohoka	PLO	Pelorus	RXB	Roxburgh
MOE	Motea	OHP	Ohaupo	PLP	Pleasant Point	SA	St Arnaud
MOT	Motukarara	OIA	Okoia	PM	Palmerston North	SB	Springburn
MOV	Morrinsville	OIH	Ohai	PMA	Papamoa	SCG	Scargill
MPE	Maungatapere	OK	Opunake	PN	Picton	SCK	Spring Creek
MPK	Matatoki	OKE	Okareka	PNT	Panetapu	SD	Sheffield
MPL	Mt Pleasant	OKI	Okaiawa	PNY	Pukenui	SDL	Springdale
MPR	Manapouri	OKL	Oakleigh	POA	Paeroa	SDN	Seddon
MPU	Maungatapu	OKN	Ohakune	POB	Poolburn	SEF	Sefton
MPX	Mapua	OKO	Okoroire	POG	Pongaroa	SFD	Stratford

ESA	Esa Name	ESA	Esa Name	ESA	Esa Name	ESA	Esa Name
SHB	St Heliers	TIO	Tirohanga	UMO	Upper Moutere	WKP	Whakapara
SHN	Shannon	TIR	Tirau	UNP	Urewera National Par	WKU	Waiuku
SKH	South Kaipara Head	TIS	Three Kings	UP	Upper Hutt	WKW	Waikiwi
SN	Sanson	TK	Temuka	UPN	Upper Hutt North	WLB	Willowbank
SOD	South Dunedin	TKE	Te Kaha	URE	Urenui	WLD	Wakefield
SOU	Southbridge	TKG	Tokanui	UTI	Uriti	WLN	Walton
SPE	Spencerville	TKK	Te Karaka	WA	Wairoa	WM	Waimauku
SPF	Springfield	TKO	Tikokino	WAA	Whataroa	WMG	Waimangaroa
SPN	Springston	TKT	Te Kuiti	WAD	Wardville	WMK	Waimahaka
SR	Shirley	TKU	Tuakau	WAE	Waikanae	WMM	Whangamomona
STA	St Andrews	TKW	Te Kowhai	WAF	Waiau Pa	WMN	Waimana
STI	South Invercargill	TKY	Tokomaru Bay	WAH	Waihi	WN	Wellington
STJ	Studholme	TMK	Tamaki	WAK	Waitakere	WND	Woodend
STK	Stoke	TMN	Taumarunui	WAO	Waotu	WNK	Wanaka
STL	St Albans	TN	Tinui	WAU	Waianiwa	WNL	Waituna West
STM	Strathmore	TNA	Takapuna	WAY	Washdyke	WNU	Wakanui
SUM	Sumner	TNU	Te Anau	WB	Ward	WO	Winton
SV	Stokes Valley	TO	Toko	WBA	Waihau Bay	WOA	Wainuiomata
SWO	Spotswood	TOB	Tokoroa	WBH	Waihi Beach	WOK	Waikoikoi
TA	Te Puna	TOI	Towai	WBY	Welcome Bay	WP	Westport
TAA	Taitapu	TOK	Tokomaru	WCM	Winchmore	WPI	Waipahi
TAE	Tauhei	TP	Tapanui	WD	Waipu	WPR	Waipara
TAI	Tariki	TPE	Taihape	WDL	Woodlands	WPU	Wakatipu
TAK	Takaka	TPI	Taupiri	WDV	Woodville	WR	Whangarei
TAP	Tapu	TPO	Taupo	WE	Waimate	WR1	Whangarei 1
TAR	Tairua	TPR	Tapora	WEB	Weber	WRE	Warea
TAT	Te Atatu	TPS	Te Puia Springs	WEI	Whenuapai	WRH	Whangarei Heads
TAU	Te Pahu	TPU	Takapau	WEN	Whenuakite	WRK	Wairakei
TAW	Te Awamutu	TPV	Te Puke	WFD	Wellsford	WRM	Waimarama
TBY	Torbay	TPW	Tapawera	WG	Wanganui	WRU	Wairau Valley
TDL	Taradale	TRA	Turua	WGA	Waerenga	WRY	Woodbury
TEA	Taneatua	TRF	Turitea	WGE	Wanganui East	WS	Wanstead
TEF	Te Akau	TRG	Te Ranga	WGH	Whangara	WSF	Westerfield
TEG	Te Anga	TRL	Te Araroa	WGL	Wanganui Girls Colle	WSR	Windsor
TEK	Te Kawa	TRS	Tarras	WGM	Whangamata	WT	Waitara
TEP	Te Poi	TRV	Te Rapa	WGU	Whangaehu	WTA	Whatatutu
TEY	The Key	TSM	Tasman	WH	Waiheke	WTB	Whitby
TG	Tauranga	TTA	Tarata	WHD	Whitford	WTE	Waiterimu
TGB	Tolaga Bay	TTE	Tuatapere	WHI	Waiotahi	WTH	Wellington South
TGI	Turangi	TTI	Tutira	WHK	Whakatane	WTI	Waitati
TG1	Motiti Island	TTK	Te Teko	WHN	Whangaruru	WTN	Waitangirua
TGN	Titirangi	TTR	Tahunanui	WHR	Waiharara	WTO	Waitoa
TH	Thames	TU	Timaru	WHT	Whitianga	WU	Waiau
THE	Te Pohue	TUA	Turakina	WHV	Waihopai Valley	WUA	Waiatarua
THK	Taheke	TUB	Tuai	WHW	Whatawhata	WUK	Waimamaku
THN	Tahuna	TUK	Te Uku	WI	Waipawa	WUR	Wainuioru
THO	Te Horo	TUP	Te Puru	WI1	Waipawa 1	WV	Waverley
THP	Thorpe	TUW	Te Kauwhata	WI2	Waipawa 2	WW	Warkworth
THR	Te Aroha	TWA	Tawa	WIL	Willowby	WWS	Wairoa West
THS	Tihoi South	TWE	Tauwhare	WIR	Waiouru	WY	Waipukurau
THU	Te Hauke	TWH	Tauwhareparae	WK	Waikouaiti	WYD	Wyndham
TIB	Titahi Bay	TWL	Twizel	WKG	Waitakaruru		
TII	Tikitiki	TY	Thornbury	WKK	Waikaka		

APPENDIX 10: GQ-AAS WIRELESS COST CAP REPORT

Public

NEW ZEALAND COMMERCE COMMISSION

TSO WIRELESS CAP MODEL 2003 - 2006

REPORT

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ABOUT THIS DOCUMENT

TITLE: Report

PROJECT NAME: TSO Wireless Cap Model 2003 – 2006

PROJECT NO: 61664

AUTHORISED: Cliff Gibson

ABSTRACT: The New Zealand Commerce Commission is in the process of determining the TSO instrument for the periods 2003/04, 2004/05 and 2005/06. Gibson Quai – AAS has been commissioned by the Commerce Commission to estimate the cost of access using a range of suitable wireless access technologies for the delivery of TSO services. The process involved examination of the most suitable wireless access technologies, selection of the technologies that met appropriate selection criteria and development of annualised cost models that calculated the cost of delivering TSO services in New Zealand ESAs for the relevant periods. The Commerce Commission, at a later stage, has modified the model to also include a Net Present Value for each of the selected technologies.

DOCUMENT HISTORY

Rev	Date	Description	Author	Reviewed
Rev A	29/08/05	First internal draft	CG	PC
Rev B	09/08/05	Internal draft selected technologies added	CG	PC
Rev C	11/10/05	Model assumptions and description added	PC	NP/CC
Rev D	17/10/05	Input from Nick Pazolli added	PC	GW
Rev E	28/10/05	Internal draft	PC	CC
Rev F	07/11/05	Commerce Commission input added	PC	CG
Rev G	9/11/05	Final draft	CG	GW
Rev 1	23/01/06	Final issued to the Commerce Commission	CG	BC
Rev 2	14/07/06	Issued to Commerce Commission as draft after comments.	TA	PC/CG
Rev 3	18/07/06	Re-issued to Commerce Commission.	TA	PC/CG
Rev 4	21/07/06	Re-issued to Commerce Commission for final review	PC	CG
Rev 5	18/10/06	Commerce Commission input added	TA	CG
Rev 6	26/10/06	Revised model input added	TA	TA/PC
Rev 7	03/11/06	Final Issue to Commerce Commission	TA	CG
Rev 8	08/03/07	Removal of cluster one customers, core network costs and introduction of Base Site type E (30m mast)	TA	CG

Rev 9	07/06/07	Commerce Commission introduced Net Present Value to model	TA	CG

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1. EXECUTIVE SUMMARY

1.1 BACKGROUND

In March 2005 the New Zealand Commerce Commission (the "Commerce Commission") published its "Determination for TSO Instrument for Local Residential Service (TSO) for the period between 1 July 2002 and 30 June 2003". This determination relied in part on a model that Gibson Quai – AAS Pty Ltd (Gibson Quai - AAS) produced to calculate the annual cost of providing TSO services to commercially non-viable customers in New Zealand exchange service areas (ESAs) located in geographic areas where wireless or radio technology provided a more cost effective access than copper.

In that year Airspan 4000 radio technology was deemed to be representative of the most suitable technology for use in New Zealand in the selected areas. Other technologies were considered and found not to be suitable in the 2002/03 year.

1.2 THIS REPORT

This report provides Gibson Quai - AAS advice on the relevant technologies and related cost of access to commercially non-viable customers in New Zealand ESAs in the financial years 1 July 2003 to 30 June 2004, 1 July 2004 to 30 June 2005 and 1 July 2005 to 30 June 2006.

Under instruction from the Commerce Commission, some ESAs included in the design for the financial year 1 July 2002 to 30 June 2003 have been removed for the periods considered in this report. The Commerce Commission has specified the costs to be used by Gibson Quai – AAS for a range of components.

1.2.1 Summary

In order to determine appropriate wireless access technologies for each financial year, a set of technology selection principles is developed in Section 4. A range of potential technologies are evaluated against the selection principles, resulting in the selection of the following technologies for use in models to calculate the cost of access to TSO services:

- Point-to-Multipoint (Section 8);
- GSM (Section 9);
- CDMA (Section 10).

Section 7 outlines the assumptions and architecture common to the cost model for all three technologies.

1.2.2 Results

The application of the design and assumptions discussed in this report resulted in the calculation through the use of an excel spreadsheet model of average cost per customer for wireless based access in their respective ESA.

These results are presented in Section 11 for each of the three years modelled.

2. INTRODUCTION

2.1 BACKGROUND TO THIS STUDY

In March 2005 the Commerce Commission published its "Determination for TSO Instrument for Local Residential Service for period between 1 July 2002 and 30 June 2003". This determination relied in part on a model that Gibson Quai - AAS produced to calculate the annual cost of providing TSO services to customers in ESAs located in geographic areas described as plains or rolling plains. The model was based on the use of Airspan 4000 radio technology as that was deemed to be the most suitable representative technology for use in the New Zealand environment in the 2002/2003 period.

In order to select a suitable technology for modelling Gibson Quai - AAS established a framework for testing potential technologies and found that there were potentially 3 wireless technologies that were suitable in the 2002/03 period. These were:

1. Marconi digital multipoint system;
2. Airspan equipment;
3. SR Telecom equipment (SR500 multi-access radio similar to IRT2000 and NEC HCRCS).

After careful analysis of these technologies and their potential use in the model to calculate the lowest service cost (while still meeting service quality standards), in areas described as plains or rolling plains Gibson Quai - AAS concluded that the Airspan technology was the most appropriate for this modelling exercise and hence it was used for all ESAs considered.

At that time Gibson Quai - AAS was advised that the Commerce Commission did not consider satellite (VSAT) or IP wireless (SOMA) to be suitable technologies for use in the relevant period and hence they were not modelled. Satellite was unsuitable as there was no domestic hub available. In the case of SOMA, we were advised that trial equipment deployments began in 2002/2003 and therefore it was not considered sufficiently mature for New Zealand TSO purposes.

Furthermore despite the fact that cellular mobile technologies were used for cost modelling of the USO in Australia during the relevant period Gibson Quai - AAS did not consider those technologies to be suitable because the TSO traffic data bandwidth requirements were greater than that required in Australia and in our opinion cellular mobile technology did not at that time comply with the TSO performance requirements.

The Commerce Commission is now determining the TSO instrument for the periods 1 July 2003 to 30 June 2004, 1 July 2004 to 30 June 2005 and 1 July 2005 to 30 June 2006. As a result Gibson Quai - AAS has been commissioned to provide advice on suitable wireless access technologies for the relevant periods and to advise on the relevant costs for the delivery of TSO services using these technologies.

Consistent with our commission this report examines wireless access technologies for the relevant periods and makes recommendations in relation to the most suitable technologies that meet the required criteria as specified by the Commerce Commission. The report describes the process of modelling the costs of delivering TSO services to customers in specific New Zealand ESAs for the periods 2003/04, 2004/05 and 2005/06.

2.2 TSO

The New Zealand Telecommunications Act 2001, which was recently amended in December 2006, regulates the supply of telecommunications services in New Zealand. Part 3 of the Act facilitates the supply of certain telecommunications services to end-users within New Zealand who may not otherwise be supplied on a commercial basis, or at an affordable price. This is the Telecommunications Service Obligation (TSO). The telecommunications services as specified in the TSO include the following provisions:

1. Provision of basic telephone access as widely available as it was at 20 December 2001;
2. free local calling;
3. internet access (at least 95% of residential lines meeting 14,400 bit/s, and at least 99% meeting 9,600 bit/s);
4. free listing in the White Pages;
5. free genuine 111 emergency calls and;
6. a monthly line rental no higher than the CPI adjusted price of the residential line rental charged at 1 November 1989.

The Commerce Commission provides an annual determination of the cost incurred for the supply of those services by Telecom New Zealand (TNZ) under the TSO Deed. It also determines the allocation of this cost among liable persons in the telecommunications industry, and assesses TNZs compliance with the TSO Deed quality standards.

3. CONSTRAINTS ON THIS STUDY

3.1 BACKGROUND

This study and related model has been conducted within the constraints associated with the legislative framework, the modelling methodology selected by the Commerce Commission and practical limitations on access to supplier equipment pricing. The modelling methodology limits the number of ESAs that were used for modelling the cost of access and hence implies certain demographic and geographic constraints on the modelled outcomes. Specifically the Commerce Commission advised Gibson Quai – AAS to base the access cost models on 14 selected ESAs.

3.2 LEGISLATIVE

The legislative framework under which the TSO instruments are defined is given in Part 3 of the New Zealand Telecommunications Act 2001. Subpart 2 of Part 3 of the Act prescribes the annual procedures undertaken by the Commerce Commission for determining the net cost of the TSO and the amounts payable by liable persons to the telecommunications service provider (TSP) as a contribution towards this cost. The Commerce Commission is required under Section 80 of the Act to make an annual assessment of a TSP's compliance with a TSO instrument. This study provides an input into the Commerce Commission's annual review of the TSO in reviewing the estimated (capped) costs and most appropriate technologies for connecting Commercially Non-Viable Customers (CNVC's) using wireless local loop technologies.

3.3 TSO MODEL

The definitions and methodologies applied in determining the TSO by the Commerce Commission[1] are taken as a given in this study. These include:

1. Unavoidable Incremental Cost: - The additional cost a firm would incur if it chose to serve an extra customer or group of customers, or provide an extra unit or tranche of output. In estimating the net cost of the TSO, the Commerce Commission regards the unavoidable incremental costs as the difference between the long-run costs an efficient service provider would incur with and without the obligations imposed by the TSO instrument. This cost includes a return on incremental capital required to meet the obligations under the TSO instrument, as well as appropriate depreciation costs of those assets.
2. Commercially Non-Viable Customers: - The groups of customers in respect of whom the efficient incremental costs of providing the TSO services exceed the standard residential line rental plus the expected supplementary revenue. Each group of customers is considered as either a viable or non-viable cluster of customers. The non-viable clusters of customers are those for whom the cost of providing their services exceeds the price cap. The sum of the net costs of all the non-viable clusters is then the total TSP net cost.
3. Efficient Service Provider: - One who produces a given quantity and quality of service for the lowest possible cost. The Commerce Commission estimates the price caps on the basis of the costs that would be incurred if the TSP were operating efficiently.
4. Modern Equivalent Asset: - Within a forward looking network, a modern equivalent asset (MEA) is the equivalent item of equipment that would be used if an outdated asset in the network were to be replaced, given current best practice.
5. Tilted Depreciation Methodology: - The capital costs are adjusted over time in line with the rate of increase or decrease of the Optimised Replacement Cost of the capital equipment. If the replacement cost of a piece of equipment is declining over time then the depreciation charge in the early life of the equipment would be higher, if the replacement cost is increasing over time then the depreciation charge in the early life of the equipment would be lower.
6. Weighted Average Cost of Capital (WACC): - The weighted average of the costs of debt and equity as applied in the Brennan-Lally Capital Asset Pricing Model (CAPM).

3.4 TECHNOLOGY COSTING DATA

In order to develop a view on capital and operating costs, Gibson Quai - AAS initially sought cost information from a range of sources some of which are confidential. In cases where detailed cost information was unavailable, Gibson Quai - AAS has determined a reasonable cost based on our experience and work undertaken on previous projects. These costs were incorporated in the draft model which was released by the Commerce Commission for industry comment in December 2005.

[1] Determination for TSO Instrument for Local Residential Service for period between 1 July 2002 and 30 June 2003.

As a result of industry feedback and in collaboration with the Commerce Commission the model has been updated in a number of areas and some of the input costing data modified to reflect actual costs that have been experienced in New Zealand or could expect to be experienced by an efficient operator implementing a large scale wireless or radio access network in New Zealand.

4. TECHNOLOGY SELECTION PRINCIPLES

4.1 REGULATORY FRAMEWORK

As indicated above, in order to estimate the net cost of the TSO the Commerce Commission has defined a number of key terms which provide the guiding principals, including:

1. unavoidable incremental cost;
2. an efficient service provider; and
3. CNVCs.

These definitions are included in the Commerce Commissions TSO determination[2] for the 2002/03 year.

We have relied on these definitions for the purposes of not only development of the technology selection principals but also the pricing of network elements that have been included in the models.

The important components of the definitions which have influenced our thinking are as follows:

1. In estimating the net cost of the TSO it is necessary to include a return on incremental capital required to meet the obligations under the TSO instrument, as well as appropriate depreciation costs of those assets.
2. Common costs of providing services to commercially viable customers and CNVCs are part of the core network. These costs are not related to the provision of TSO service that has been provided as a virtual build out from the exchange node. Only those costs that are related to replacing the scorched local access network have been included.
3. The incremental cost should be the long run incremental cost (LRIC).
4. The smallest group of residential customers served by a fixed line access network to which costs ought to be attributed, is a cluster; that is, the group of customers connected to the same feeder cabinet.
5. The costs used to calculate the TSO instrument should be consistent with the lowest costs that an efficient service provider would have incurred in delivering the services in a competitive environment.
6. The model should be based on a scorched node approach to TSO cost modeling of services to TNZ's existing ESAs. This means that existing nodal locations should be assumed in the wireless access models and the reach of wireless coverage should be constrained by defined model boundaries.

[2] Determination for TSO Instrument for Local Residential Service for period between 1 July 2002 and 30 June 2003.

4.2 TECHNOLOGY SELECTION PRINCIPLES

The following principles have been applied to the selection of technologies from the pool of potential technologies. These principles have been applied in each of the relevant years.

4.2.1 Principle 1: Availability

Technologies are only available if they have been made available for supply on an on-going commercial basis by suppliers, and if the person responsible for telecommunications service delivery could negotiate reasonable access to products and systems incorporating the technology on a continuing, commercial basis.

4.2.2 Principle 2: Suitability

Technologies are only suitable for TSO service delivery if they meet the criteria of being proven, robust, non-obsolescent, terrain compatible, capable of being integrated into existing networks and have supplier support as outlined below:-

a) Proven:

The technology must be proven in the sense of being fully operational according to its design, and having been accepted as a feasible, working technology by the developers and major users around the world, as at the relevant date.

b) Robustness:

The technology must have been successfully tested in operational circumstances, and be capable of operation under load and stress conditions.

c) Non-obsolescence:

The technology must not be obsolete and must not have been effectively replaced by later technologies in new installations by technically advanced carriers around the world. (In the interests of clarity, Gibson Quai - AAS does not believe that this criterion automatically excludes all analogue technologies. Some, such as analogue cellular radio technologies have radio spectrum constraints imposed by the Government, and would be excluded for that reason).

d) Terrain Compatibility:

The technology must be capable of operating to design specification in terrain of the kinds encountered by the New Zealand CNVCs.

e) Network Integration:

The technology must be capable of being integrated into or interconnected with the existing TNZ network (or another carrier's network) in the sense that the existing network delivers services to customers the vast majority of whom are not included in the assessment.

f) Supplier Support:

The technology must be supported by the equipment supplier in the area in which it is to operate in terms of higher level maintenance support and spare parts. In addition, the technology must be capable of being supported by the deploying carrier. The technology must have been available for potential implementation in New Zealand as at the relevant date. This criterion is also linked with obsolescence.

4.2.3 Principle 3: Conformance

Technologies are only suitable for TSO service delivery if they comply with all relevant New Zealand regulations codes and standards, which might reasonably be applied to the New Zealand environment during the relevant periods.

The principle instrument is the Telecommunications Service Obligations (TSO) Deed for Local Residential Telephone Service.

From this deed we have extracted the relevant requirements as outlined in the schedules to the deed which will impact on the conformance of potential technologies and on the construction of suitable models with those technologies capable of delivering the TSO.

The following table summarises the relevant criteria:

Relevant Criteria	Deed reference
Local free-calling capability.	Schedule Part 1 - Service Definitions (Section 2.1)
Calls to originate and terminate at customer's premises.	Schedule Part 1 - Service Definitions (Section 2.1)
Voice calls to emergency services.	Schedule Part 1 - Service Definitions (Section 2.5)
Support standard facsimile service.	Schedule Part 1 - Service Definitions (Section 5)
Support standard internet calls via dial up modems and line speeds of at least 14.4 kbit/s.	Schedule Part 2 - Service Quality Measures (Section 11.1)
Have a call connection success level of at least 99% which includes both standard residential voice and Internet connections.	Schedule Part 2 - Service Quality Measures (Section 11.3 & 11.4)
Maximum average switch down time per line to be less than 50 minutes per year.	Schedule Part 2 - Service Quality Measures (Section 11.5)
Standard call is a dialled, switched service with an analogue transmission bandwidth of no greater than 3.1 kHz.	Schedule Part 3 – Interpretation (Section 13.23)

Table 4-1: Relevant TSO Deed criteria.

The criteria in the principles outlined above overlap in application. This is not a problem, however, given that the separate criterion stresses different characteristics that technologies must have or avoid.

4.3 EXPLANATION OF TECHNOLOGY SELECTION PRINCIPLES

The explanation of why the recommended principles have been selected and other possible principles have been rejected for the purpose of calculating the wireless cap is as follows.

4.3.1 Reasons for Adoption

The principles appear to reflect the practical considerations that would be taken into account by a technically competent and efficient carrier in establishing a network to deliver services in the CNVC areas. Specifically, such a carrier would limit its consideration of technology to that which was commercially supported and available, and which was suited to the task of providing service in rural and remote locations. Such technologies would need to be proven as robust for environments and terrain such as that encountered in rural and remote New Zealand. However it need not be proven under specific New Zealand conditions by actual field service. In addition, technology selection would be for the longer term, and would therefore not be at, or nearing, an obsolescent nature at the time of implementation. Furthermore the technology must be capable of being integrated or interconnected with networks that provide other telephone services. As part of this consideration, the technology would have to be fully supported by the supplier and comply with New Zealand regulatory codes and standards.

On the other hand, Gibson Quai - AAS concludes that a carrier responsible for establishing a network to deliver TSO services would not be constrained to consider only technologies that have been adopted by an incumbent such as TNZ, or technologies that have been tested and operationally implemented in specific New Zealand conditions. Gibson Quai - AAS therefore recommends that principles or criteria based on these factors should not be adopted.

4.3.2 Principles That Have Not Been Adopted

Gibson Quai - AAS has considered the following statement of principles for selecting wireless cap technologies and believe that they should not be adopted by the Commerce Commission for the purpose of the TSO.

a) New Zealand Track Record

This principle would require all technologies for consideration in assessing the TSO to have been installed in New Zealand to provide service to CNVCs. Such a principle would have the advantage of enabling the capital and operational costs to be based on direct experience in situ. On the other hand, such a principle would limit consideration of technologies to those already chosen by TNZ. This principle would be contrary to the notion of an efficient provider utilising forward looking technology. For that reason alone, Gibson Quai - AAS recommends that the principle not be adopted by the Commerce Commission.

b) The Telecom New Zealand Test

This principle of selection would exclude technologies that TNZ would not install today because they have been superseded or have become obsolete or are not adequately supported by suppliers. As stated the principle is too constraining in that it limits consideration to technologies that TNZ has chosen in practice, and may exclude other forward looking technologies from consideration only on the basis that TNZ has not adopted them yet. Those elements of the suggested principle relating to obsolescence and supplier support have already been covered in the recommended criteria.

Gibson Quai - AAS would advise against the adoption of any principle that is based on a TNZ test or adoption of a technology by any particular carrier.

c) Significance Test

This criterion is based on the notion that if a technology is a niche technology and not likely to deliver a material number of services for TSO purposes then it should be dismissed from consideration. Gibson Quai - AAS recognises this as a practical issue, but recommends against elevating it to the level of an exclusionary principle. Integration and unit costs will likely cause such technologies not to be most cost effective – otherwise they deserve consideration on cost grounds alone.

5. RECOMMENDED POOL OF POTENTIAL TECHNOLOGIES

There are a very large range of potential technical solutions which might be considered, however in the interest of reasonableness in the selection of technologies we have searched for technologies based on wireless electromagnetic transmission principles that might potentially find application in a carrier environment.

We have not included technologies that are aimed at domestic (home) use or that clearly have no potential for use in the provision of the TSO because they would not meet carrier grade service levels.

The following is a list of potential technologies that were considered:

Potential Technology	Example Type
Point to point	
Customer radio telephone	Excom Hawke
Small capacity	n x E1: Longreach, Alcatel
Medium capacity	34 Mbit/s: NEC, Alcatel, Ceragon
High capacity	155 Mbit/s: Ceragon, NEC, Siemens, Marconi AXR

Point to multipoint	
Multi-access radio concentrator	IRT2000
	NEC HCRCS
	SR500
Wireless local loop	IPWireless
	iBurst
	Marconi MDMS
	Airspan 4020
	Qualcomm Flarion
	Alvarion
	Navini Networks
	SOMA
	Siemens SkyMAX
	Proxim/Terabeam
LMDS	Alcatel 7390
MMDS	Alvarion BreezeACCESS

Satellite	
LEO/MEO	Iridium, GlobalStar
GEO	Inmarsat

Mobile telephony	
GSM	Vodafone
CDMA	TNZ
3G	Vodafone
3G	Telecom/Hutchison

Table 5-1: List of potential technologies

6. SELECTED TECHNOLOGIES

The following sections provide details of the analysis undertaken by Gibson Quai - AAS in relation to selection of suitable wireless technologies for the relevant years. The selection principles discussed above have been applied on a technology by technology basis and only when all of the criteria have been met has a technology been deemed to be suitable.

6.1 2003 – 2004

Potential Technology	Example type	Availability	Proven	Suitability					Conforming	Overall Suitability
				Robust	Not Obsolecent	Terrain compatible	Can be integrated	Supplier support		
Point to point										
Customer radio telephone	Exicom Hawke	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Small capacity	n x E1, Longreach, Alcatel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Medium capacity	34 Mbit/s, NEC, Alcatel, Ceragon,	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High capacity	155 Mbit/s, Ceragon, NEC, Siemens, Marconi AXR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Point to multipoint										
Multi-access radio concentrator	IRT2000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	NEC HCRCS	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
	SR500	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Wireless local loop	IPWireless	No	Yes	No	Yes	Yes	No	No	Yes	No
	iBurst	No	No	No	Yes	Yes	No	No	No	No
	Marconi MDMS	No	No	No	Yes	Yes	Yes	No	Yes	No
	Airspan 4020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Qualcomm Flarion	No	No	No	Yes	Yes	No	No	No	No
	Alvarion WALKair	No	Yes	No	Yes	Yes	Yes	No	Yes	No
	Navini Networks	No	No	No	Yes	Yes	No	No	Yes	No
	SOMA	No	No	No	Yes	Yes	Yes	No	Yes	No
	Siemens SkyMAX	No	No	No	Yes	Yes	Yes	No	Yes	No
	Proxim/Terabeam	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
LMDS	Alcatel 7390	No	No	No	Yes	No	Yes	No	Yes	No
MMDS	Alvarion BreezeACCESS	No	Yes	Yes	Yes	Yes	No	No	No	No
Satellite										
LEO/MEO	Iridium, GlobalStar	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
GEO	Inmarsat	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Mobile telephony										
GSM	Vodafone	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CDMA	Telecom NZ	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3G	Vodafone	No	No	No	Yes	Yes	Yes	Yes	Yes	No
3G	Telecom/Hutchison	No	No	No	Yes	Yes	Yes	Yes	Yes	No

Table 6-1: 2003 – 2004 technologies.

6.2 2004 – 2005

Potential Technology		Example type	Availability	Suitability							Conforming	Overall Suitability
				Proven	Robust	Not Obsolecent	Terrain compatible	Can be integrated	Supplier support			
Point to point												
	Customer radio telephone	Exicom Hawke	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
	Small capacity	n x E1, Longreach, Alcatel	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
	Medium capacity	34 Mbit/s, NEC, Alcatel, Ceragon,	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
	High capacity	155 Mbit/s, Ceragon, NEC, Siemens, Marconi AXR	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Point to multipoint												
	Multi-access radio concentrator	IRT2000	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
		NEC HCRCS	Yes	Yes	Yes	Yes	Yes	Yes	No		Yes	No
		SR500	Yes	Yes	Yes	Yes	Yes	Yes	No		Yes	No
	Wireless local loop	IPWireless	Yes	Yes	Yes	Yes	Yes	No	No		Yes	No
		iBurst	Yes	No	No	Yes	Yes	No	No		No	No
		Marconi MDMS	No	No	No	Yes	Yes	Yes	No		Yes	No
		Airspan 4020	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
		Qualcomm Flarion	No	No	No	Yes	Yes	No	No		No	No
		Alvarion WALKair	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
		Navini Networks	Yes	No	No	Yes	Yes	No	No		Yes	No
		SOMA	Yes	No	No	Yes	Yes	Yes	Yes		Yes	No
		Siemens SkyMAX	No	No	No	Yes	Yes	Yes	No		Yes	No
		Proxim/Terabeam	Yes	Yes	Yes	Yes	Yes	No	Yes		No	No
	LMDS	Alcatel 7390	Yes	No	No	Yes	No	Yes	Yes		Yes	No
	MMDS	Alvarion BreezeACCESS	Yes	Yes	Yes	Yes	Yes	No	No		No	No
Satellite												
	LEO/MEO	Iridium, GlobalStar	Yes	Yes	Yes	Yes	Yes	Yes	Yes		No	No
	GEO	Inmarsat	No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	No
Mobile telephony												
	GSM	Vodafone	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
	CDMA	Telecom NZ	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
	3G	Vodafone	No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	No
	3G	Telecom/Hutchison	No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	No

Table 6-2: 2004 – 2005 technologies. *Shaded cell indicates change from previous year*.

6.3 2005 – 2006

Potential Technology	Example type	Availability	Suitability						Conforming	Overall Suitability
			Proven	Robust	Not Obsolecent	Terrain compatible	Can be integrated	Supplier support		
Point to point										
Customer radio telephone	Exicom Hawke	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Small capacity	n x E1, Longreach, Alcatel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Medium capacity	34 Mbit/s, NEC, Alcatel, Ceragon,	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High capacity	155 Mbit/s, Ceragon, NEC, Siemens, Marconi AXR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Point to multipoint										
Multi-access radio concentrator	IRT2000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	NEC HCRCS	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
	SR500	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Wireless local loop	IPWireless	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
	iBurst	Yes	Yes	Yes	Yes	Yes	No	No	No	No
	Marconi MDMS	Yes	No	No	Yes	Yes	Yes	No	Yes	No
	Airspan 4020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Qualcomm Flarion	Yes	No	No	Yes	Yes	No	No	No	No
	Alvarion WALKair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Navini Networks	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
	SOMA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Siemens SkyMAX	Yes	No	No	Yes	Yes	Yes	No	Yes	No
	Proxim/Terabeam	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
LMDS	Alcatel 7390	Yes	No	No	Yes	No	Yes	Yes	Yes	No
MMDS	Alvarion BreezeACCESS	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Satellite										
LEO/MEO	Iridium, GlobalStar	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
GEO	Inmarsat	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Mobile telephony										
GSM	Vodafone	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CDMA	Telecom NZ	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3G	Vodafone	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
3G	Telecom/Hutchison	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Table 6-3: 2005 – 2006 technologies. *Shaded cell indicates change from previous year*.

6.4 DESCRIPTION OF AVAILABLE TECHNOLOGIES

6.4.1 Satellite

In previous (2002/03) TSO determinations, satellite derived services were excluded because New Zealand did not have a domestic hub.

Satellite based technologies which would potentially be suitable for domestic telephony and Internet data are examined in this section to determine if the status has changed, and if they could be used in the relevant years as considered by the study.

Two satellite based technologies are considered:

a) Geostationary earth orbit (GEO) satellite systems;

b) Low earth orbit (LEO) or medium earth orbit (MEO) satellite systems.

6.4.1.1 Geostationary earth orbit (GEO) satellite systems

These systems require fixed earth based infrastructure at a point suitable for interconnection to the public switched telephone network and at the telephone customer end. Antennas are fixed in azimuth and elevation, directed to a satellite positioned stationary in relation to earth stations. The distance to the satellites is in the order of 36,000 km and round trip transmission delay is in the order of 500 ms.

Examples of GEO systems are Inmarsat, Intelsat, PanAmsat, Optus and iPStar.

6.4.1.2 Low earth orbit (LEO) or medium earth orbit (MEO) satellite systems

These systems require fixed earth based infrastructure at a point suitable for interconnection to the public switched telephone network. At the telephone customer end, antennas are smaller in size compared to the GEO case. The cluster of satellites move in relation to the earth stations and communications circuits must be handed off from one satellite to the next. The distance to these satellites is in the order of 2,000 to 10,000 km and round trip transmission delay is approximately 30 to 150 ms, plus processing delay gives an aggregate circuit delay of typically 150 – 250 ms.

Examples of LEO/MEO systems commercially available in the years considered in this report are Iridium and GlobalStar.

6.4.1.3 Findings

1. Stratos

   Gibson Quai - AAS contacted Stratos, Auckland. Stratos operates an earth station facility in Albany which is potentially suitable for terminating telephone/data traffic from remote customers across New Zealand.

   The Stratos earth station facility (originally a British Telecom facility) became operational in Auckland in 1997.

   Stratos serves as an International (Inmarsat) Hub for offshore aircraft, shipping and land mobile telecommunication services. Stratos is connected to the global terrestrial PSTN, ISDN and Internet networks via TelstraClear and also via Stratos's own extensive global terrestrial leased line network (which connects to Stratos PoP worldwide). There is also interconnection with TNZ but traffic in either direction between Stratos and TNZ is predominantly international telecommunications traffic (i.e. not domestic)[3].

The Stratos facility is not dimensioned to carry the PSTN traffic from remote NZ telephone customers. These traffic levels have a peak in the order of 400 Erlangs (rate derived for TSO)[4], hence Stratos is not considered a suitable solution for the TSO.

2. iPSTAR

iPSTAR New Zealand Limited (iPSTAR NZ), a wholly owned subsidiary of Shin Satellite Public Company Limited Thailand, has established a gateway hosting and facilities service in Albany, Auckland New Zealand.

"The iPSTAR Broadband Satellite System will provide telecommunications and multimedia services to households and public organisations. Consumers will have a wide variety of pay television and video on demand services, low cost IP voice telephony, and high-speed internet connections. Organisations will access two-way high-speed corporate "Internet Works" and use Ultra Small Aperture Terminals ("USAT") or Virtual Private Networks (VPN) in addition to consumer services." [5]

Internet Service Provider ICONZ is buying wholesale bandwidth from iPSTAR and satellite antenna and customer premises equipment from Shin to deliver broadband to 63 rural schools in New Zealand.

The Shin satellite iPSTAR-1 was launched in August 2005 and is under going stabilisation testing and commissioning in September 2005.

3. LEOs and MEOs

Although LEO/MEO systems can be dimensioned in small quantities (less than 10's for New Zealand) of customer terminals for data capacities up to 64 kbit/s, the typical rate is approximately 2.4 kbit/s per circuit.

These systems are more suited to low call rates or very remote applications where no other technical solution is practical.

LEO/MEO solutions are not considered to be a suitable technology for the TSO.

4. TNZ

Gibson Quai - AAS understands[6] that TNZ does not have suitable domestic hub facilities in New Zealand. TNZ operates an earth station facility at Warkworth north of Auckland, however the facility does not have a hub for domestic two way satellite service.

Further, TNZ did not route New Zealand based domestic VSAT traffic via hubs in Australia during the period 2003 to 2005.

TNZ has no plans at present to use iPStar satellite hub to serve remote customers. It was explained that "…any VSAT service will incur considerable backhaul costs and face potential double-hop service for customers within the same locality making calls."

[3] Advice from Eric Jones, Managing Director, Stratos New Zealand Ltd, 5 September 2005

[4] Rate derived by Gibson Quai - AAS based on typical telephony traffic requirements.

[5] http://www.mfat.govt.nz/foreign/tnd , 2004

[6] John Wesley-Smith, Telecom New Zealand, 1 November 2005

6.4.1.4 Conclusion

Satellite based technology is not a suitable technology solution for 2003/04, 2004/05 or 2005/06, because a fully supported and adequately dimensioned domestic hub was not available during the period.

However, satellite solutions should be considered for 2006/07 because we anticipate that a suitable domestic hub will be in place.

6.4.2 GSM

GSM (Global System for Mobile Communications) is the most popular second generation cellular communications technology worldwide. GSM is a Time Division Multiple Access (TDMA) system operating in the 900 MHz or 1800 MHz band.

The GSM specification was published by ETSI in 1990, and commercial services began operating around the world in the early 1990s. A mobile data service (GPRS, General Packet Radio Service) has since been added to the GSM standard to allow data transfer over unused TDMA timeslots.

The GSM network in New Zealand is operated by Vodafone, who purchased the network in 1999.

6.4.3 CDMA

Code Division Multiple Access (CDMA) is a cellular mobile technology, originally developed by US company Qualcomm and later developed into a standard known as IS-95. Two variants are known as IS-95A and IS-95B.

CDMA (IS-95B) provides data rates of up to 14.4 kbit/s, whereas CDMA2000 1xRTT provides up to 307.2 kbit/s.

The CDMA network in New Zealand is operated by TNZ, which launched the “027” network in July 2001 to replace the analogue “025” AMPS and D-AMPS networks.

6.4.4 Point to Multipoint Radio

Point to multi-point radio technologies are comprised of two significant groups, the so called multi-access radio type (MAR), and the wireless local loop type.

Multi-access radio technologies such as IRT2000, SR500 and NEC HCRCS are suitable for very sparsely distributed customers in a limited range of locations in New Zealand. These typically operate on a time division multiple access basis, have a narrower bandwidth and lower customer numbers per system. The IRT2000 is approximately double the cost of the wireless local loop types such as Airspan. Such technologies are suitable for numbers of customers up to 200 to 400 per system and the technology has therefore not been adopted for the general case of customer numbers in the order of 1000 or more.

Wireless local loop types such as Airspan 4000 are spread spectrum technologies and more suited to higher customer concentrations, within a radius of 25 km from a base station. This technology was deemed to be suitable to New Zealand demographics and was adopted as representative of point-to-multipoint technologies that passed the selection criteria.

6.4.5 Other Technologies Not Modelled

Although they pass the test for potential technologies, the following technologies were not modelled.

Dual channel (e.g. Exicom Hawke) or very small capacity radio systems were not modelled because although such systems are suitable for servicing one customer as say an extension of a point to multipoint (multiple access) system, the technology is not suitable for large groups of customers due to frequency congestion at a nodal point and the higher relative cost of the technology in comparison to multiple access systems.

Point to point radio systems technologies are suitable for servicing large groups of customers however they would be less cost effective than optical fibre cable systems and were therefore not modelled.

6.5 TABLE OF SUITABLE TECHNOLOGIES

The following table summarises those technologies which were found to meet the requirements of the technology selection principles and hence have been used in relevant models to calculate the cost of TSO access through the use of those technologies applied to the selected ESAs.

Suitable Technology	2003 - 2004	2004 - 2005	2005 - 2006
Point to point radio links of various capacities.	YES	YES	YES
Multi-access radio concentrator (IR2000 and Airspan 4020)	YES	YES	YES
GSM	YES	YES	YES
CDMA	YES	YES	YES

Table 6-4: Table of Suitable Technologies

7. COST MODEL

7.1 INTRODUCTION

The annual cost of access per customer is calculated by the related Microsoft Excel workbook model referred to as “TSO Wireless Cap Access Model rev11 March07 CC”. The Commerce Commission has also modified this model to include a NPV per customer for the selected technologies. Gibson Quai – AAS has reviewed the modifications to ensure that they have been applied consistently, and to give effect to the NPV∞ formula in section 7.2.4.

This model is based heavily on engineered solutions developed by experienced radio engineers. It closely resembles actual solutions which would be constructed by an efficient carrier who had set about delivering services to the customers as identified using the most efficient wireless technology and related design principles in the relevant years in New Zealand.

7.2 ASSUMPTIONS

7.2.1 Tech Factor

The tech factor represents the annual percentage change in asset replacement cost as a result of technological advances in the industry. In general this factor reduces the cost of acquiring an asset in future years. Hence a tech factor of -5% means that the replacement cost of the item decreases by a compounding factor of 5% each year.

The tech factor is a time independent constant for each technology component. In an economic context the tech factor is a nominal variable, meaning the effect of inflation on the asset price has not been accounted for.

7.2.2 Tilt Factor

The real tilt factor is a combination of the tech factor and inflation:

$$Tilt_{year\_x} = (1 + Tech_{year\_x})(1 + Inflation_{year\_x}) - 1$$

The tilt factor is used in the annualisation formula as described in Section 7.2.3 and in the net present value formula as described in Section 7.2.4 . Most of the tilt factors used in the models are those used by the Commerce Commission in various determinations. Where relevant tilt factors were not available Gibson Quai - AAS made an assessment of a reasonable factor to use based on our experience.

7.2.3 Return on Capital Calculation

The annualised cost of providing customer access to the PSTN via the selected wireless technology has been calculated from the sum of the annual operating costs including related indirect costs and the annual return on capital investment including related indirect costs.

The annual return on invested capital has been calculated by multiplying the invested capital by the annualised return on capital, which is calculated from the following formula as used by the Commerce Commission in the "TSO Discussion Paper and Practice Note – Implementation Issues Paper" 19 April 2002. This formula was also used in previous work undertaken by Gibson Quai - AAS in relation to the 2002/03 TSO Wireless Cap.

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

Where:

A_t	=	The annualised return on a capital investment in year t.
t	=	A particular year in the economic life of the asset.
WACC	=	Pre-tax Weighted Average Cost of Capital.
V	=	The optimised replacement cost of the asset (capital investment).
α	=	The rate of change of the optimised replacement cost of the asset (tilt factor).
N	=	The economic life of the capital investment.

This formula has been built into the "Technology Inputs" worksheet of the model, in the annualised charge factor column.

7.2.4 Net Present Value

The Commerce Commission has modified the model to include the Net Present Value (NPV) of providing customer access to the PSTN via the selected wireless technologies. The NPV calculates the present value of future costs in relation to the provision of such access.

The Commerce Commission applied a tilted NPV methodology, the formula of which is as follows:

$$NPV = \sum_{t=0}^{life\_times} \frac{V_0 * (1+\alpha)^{t*N}}{(1+WACC)^{t*N}}$$

Where:

NPV = The Net Present Value.

Life_times = The number of present value (PV) terms to be added, each representing a technology life time of "N" years.

N = The economic life of the capital investment.

t = A particular year in the economic life of the asset.

WACC = Pre-tax Weighted Average Cost of Capital.

Vo = The year 0 ORC.

α = The rate of change of the optimised replacement cost of the asset (tilt factor).

By recognising the NPV formula as a geometric series, and summing all the terms over a long period of time (t =0 to infinity), the following formula is obtained:

$$NPV\infty = \frac{V_0}{1-(\frac{1+\alpha}{1+WACC})^N}$$

The Commerce Commission has built this formula into various sections of the model and it has been utilised to calculate the total NPV (to infinity) through the addition of the capital NPV and the operational NPV as shown in the "Technology Inputs" worksheet of the model.

7.2.5 Technology Capital Costs

The model utilises a range of telecommunications equipment, including backbone network equipment, base sites, customer premises equipment and associated items.

The cost of most items (listed in the 'Technology Costs' worksheet) is based on those costs used by Gibson Quai – AAS in point to multipoint wireless access modelling associated with the 2002/03 TSO determination. These costs were updated for later years via the methodology described in Section 7.2.6 below.

Similar methods were used to determine the cost of GSM and CDMA equipment for the development of the GSM and CDMA models.

The derivation of capital costs often come from a number of sources and the number used in the spreadsheet is generally our best estimate based on our experience, or from a source which is not confidential. However some inputs have been sourced from industry comment on the draft wireless cap model and collaboration with the Commerce Commission. The pricing in these cells is in New Zealand dollars (NZD), and, where available, New Zealand unit prices have been used. These cells are not locked and if a more informed cost estimate can be obtained then it can be inserted and the results will ripple through to the summary sheet.

7.2.6 Change in Technology Capital Cost Over Time

The capital cost of each asset was updated for future years to reflect technological advances (which usually push prices down) and general inflation (which usually pushes prices up).

For items where cost data exists from work undertaken by Gibson Quai – AAS on the 2002/03 modelling for the wireless TSO cap, this base cost was modified by the tech factor and inflation to calculate initial costs for each item in the relevant years. For other equipment, Gibson Quai - AAS has estimated the percentage contribution to the capital cost of the item from each of the following factors:

- Labour Cost Index (source: Statistics New Zealand);
- Copper Price (source: London Metal Exchange);
- Steel Price (source: MEPS);
- Oil Price (source: US Department of Energy); and
- Land value (source: Real Estate Institute of New Zealand).

The initial capital cost of each item in the relevant years (in NZD) was then calculated from the annual percentage change in each of these factors.

In addition, a tilt factor is calculated for each item in each of the years modelled, in order to calculate the annualised capital cost described in Section 7.3.2 and the net present value described in Section 7.2.4. This will be different for each year as the factor includes an inflation component.

Inflation is calculated from data available from Statistics New Zealand, and is the average of the Consumers Price Index (CPI) for four annualised terms in the relevant year.

7.2.7 Quantity per Site

In general, each site type used in the model will only require one of each specified item. For example each GSM customer site requires one GSM fixed unit, one power supply with backup battery, and one installation and cabling cost.

However for some sites another number is used. For example a GSM base site requires more than one antenna per site, depending on the design capacity of the base equipment.

Where relevant we have made our best estimate of the number items required and where appropriate relied on manufacturer dimensioning data.

7.2.8 Spares as a Percentage of Capital

It is common practice for the carrier to hold various spares to minimise the time to repair certain equipment failures and hence optimise the maintenance costs. The extent of the holding of spares is a balance between the probability of a failure occurring, the time to obtain parts and their potential availability, the cost of those parts and the quantity of equipment of a particular type that is installed in a given area. We have made our best estimate of the cost of the spares holding that an efficient operator might incur which is expressed as a percentage of the capital cost of the particular investment item to which the spares holding is relevant.

7.2.9 Asset Life

Most of the asset lives are those figures used by either the Commerce Commission in various determinations or the Australian Communications and Media Authority

(ACMA) in their Universal Service Obligation (USO) assessments. The source of the asset life figure as used in the model is indicated in the corresponding comment box.

7.2.10 Annual Operating Cost

Each technology component is given an annual operating and maintenance cost, calculated as a percentage of the original capital cost of the item. The figures used in the model are either factors adopted in various determinations by the Commerce Commission or the ACMA in their USO assessments. Where relevant annual operating costs were not available Gibson Quai - AAS has made an assessment of a reasonable factor to use based on our experience.

7.2.11 Network dimensioning

The network elements and their relevant dimensions have been selected to ensure operational performance to meet the specified performance requirements as set out in the TSO Deed for Local Residential Telephone Service and to ensure efficient operation of the equipment in compliance with normal engineering practice.

7.2.12 Choice of Backhaul Technology

GSM and CDMA technologies require the use of backhaul transmission to connect the base sites to mobile switching centres. The Commission's modelling approach has been to use the PSTN LRIC per minute cost stated in Table 7-2. The approach has assumed that the mobile network is a virtual build out of the mobile network to replace the ESAs scorched network. All elements of the mobile technology's backhaul have been removed from the modelling and replaced by the Commission supplied LRIC values.

7.3 MODEL ARCHITECTURE

The point-to-multipoint wireless model calculates the customer access cost in the relevant ESAs with assumed interconnection at the local ESA switch and hence assumes the TSO traffic is carried on the existing backbone network. The GSM and CDMA models have the same basic access architecture with the exception of backhaul transmission which is required to carry traffic to central Mobile Switching Centres (MSC) in Wellington for the North Island and Christchurch for the South Island. The existing backbone network is used to carry network originating and terminating traffic to the MSC. The following sections further describe the details of the technology architecture as modelled.

7.3.1 Global Inputs

All global input variables and values are summarised in the following table.

Input	2003 – 2004	2004 – 2005	2005 – 2006
Pre-tax WACC	9.54%	10.60%	11.40%
GSM Customers	[ ]	[ ]	[ ]
CDMA Customers	[ ]	[ ]	[ ]
Voice and Data Customers and Traffic Details	See Table 7-2	See Table 7-2	See Table 7-2

Table 7-1: Model input variables.

The draft model was based on a number of assumed customer traffic levels for the purpose of dimensioning the traffic dependant network variables. However at the Commerce Commissions request the model has been rebuilt using actual traffic levels for the relevant years and dimensioning of the traffic dependant network variables for the relevant technologies. Backhaul to the MSC has been costed using actual LRIC costs for each ESA in the relevant years.

The following table provides details of the per ESA traffic in minutes per line per year[7] and backhaul costs in cents per minute[7] as used in the model.

ESA	2003-2004			2004-2005			2005-2006		
	LINE COUNT	MINS/LINE /YEAR	CENTS/ MIN	LINE COUNT	MINS/LINE/YEAR	CENTS/ MIN	LINE COUNT	MINS/LINE/YEAR	CENTS/ MIN
ARD	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CAV	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
HDS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
MAO	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
MFD	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
OTU	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PTO	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SB	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
STA	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
THE	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
WCM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
WIL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
WRM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
WSF	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table 7-2: Input traffic data.

The line count reflects the total number of customers in the ESA without 'cluster 1' customers as of December 20, 2001 (submitted by NZCC).

Note: traffic data for the 2005/06 year was not available at the time of modelling, hence, traffic data from the 2004/05 year was used for the 2005/06 year.

The Global Inputs worksheet enables the input of variables that will impact all calculations in the model. The following table describes the input variable that may be changed from the input variables worksheet.

[7] The line count and traffic per line for each relevant ESA was sourced from TNZ restricted information. The backhaul costs were sourced from the commerce commission restricted information.

Control Variable	Initial Value	Description
Year	2003 – 2004	Allows the cost calculation to be performed for the years 2003 – 2004, 2004 – 2005 and 2005 – 2006.
t value	1	Controls the t value input to the annualisation model as described in Section 7.2.3.
ORC modifier	0%	Increases the optimised replacement cost of assets due to the Resource Management Act 1991 as instructed by the Commerce Commission. (Has been set to 0% in the rev9 of the model under instructions from the Commerce Commission)

Table 7-3: Model control variables.

Any modification to these input variables will ripple through the model and change all results.

7.3.2 Technology Inputs

The Technology Inputs worksheet calculates the total annualised cost of each wireless system element that could be part of an overall ESA wireless solution. For example, a wireless solution might consist of a number of customers with different equipment at each customer site, a wireless base site capable of providing a service to several customers and a wireless link to connect the base site to the ESA exchange. The annualised cost of each of these system elements and many others is calculated by the Technology Inputs worksheet and used in the appropriate combination as determined by the radio designer as discussed below.

The calculation of the system elements takes all of the individual items that collectively make up a single system element into consideration. It incorporates a capital cost and a life expectancy of each item. It also makes an assumption about the number of items required, the number of spares and annual operating cost.

The use of the formula as discussed in Section 7.2.3 in conjunction with the estimated life expectancy and capital cost of each item plus the annual operating cost enables the calculation of the annualised cost of each system element.

Given the number of items in each system element and the total annualised cost per item, the annualised cost per system element for each system element is calculated by this worksheet.

This sheet has also been modified by the Commerce Commission to include a net present value (as described in section 7.2.4) for system elements of the selected technologies. Given the number of items in each system element, the total investment per item, and the annual operation total per item, the worksheet calculated an itemised total investment NPV and an annual operational NPV. The gross NPV (infinity) per system element was simply a matter of summing the capital NPV and operational NPV of all the items in that system element.

7.3.3 ESA Cost Models

The worksheets, as indicated in Table 7-4, bring together all of the system elements in the combination and quantity as determined by the radio design engineer to provide a wireless based access solution for all customers in each ESA, for each of the modelled technologies. The models on these worksheets are based around each ESA and ESA clusters and take into consideration the number of customers to calculate the total annualised cost per ESA. In some cases the ESAs are subdivided into clusters and a wireless solution is developed for each cluster. In this case, the total annualised cost per ESA is simply the addition of the annualised cost for each cluster.

GSM ESA Models	CDMA ESA Models	Point to Multipoint ESA Models
GSM_2003 – 2004	CDMA_2003 – 2004	PMP_2003 – 2004
GSM_2004 – 2005	CDMA_2004 – 2005	PMP_2004 – 2005
GSM_2005 – 2006	CDMA_2005 – 2006	PMP_2005 – 2006

Table 7-4: ESA cost model worksheets.

The annualised cost for each system element as used in this worksheet is derived from the Technology Inputs worksheet as discussed above.

Similarly, a net present value per ESA was introduced by the Commerce Commission where the system element costs were also derived from the Technology Inputs worksheet.

7.3.4 Summary of Results

The summary of results for the annualised cost per customer for each ESA and technology is presented in the Global Inputs worksheet in the Output table. The Commerce Commission has also modified this worksheet to include the net present value per customer per ESA of the selected technologies.

8. POINT – TO – MULTIPOINT WIRELESS MODEL

This model was initially developed by Gibson Quai - AAS for the 2002 – 2003 TSO determination[8]. The Commerce Commission provided customer location data for ESAs in three geographic regions, which was used as the basis for development of cost models that would provide average annual cost of access per telephone service per ESA within these regions.

The engineering design of the model considered the topology of the various ESAs as well as the distribution of customers within the regions. This methodology remains the same for the three years modelled in this study; however, on the direction of the Commerce Commission, some ESAs with high customer concentrations that were modelled in 2002/03 have been excluded from this model.

8.1 ASSUMPTIONS

8.1.1 Wireless Parameters

As indicated previously one of the fundamental differences between this model and the draft model and for that matter the 2002/03 TSO Wireless Cap model was that actual customer traffic was used.

The majority of Gibson Quai – AAS's design was done through an extensive map (1:50,000 topographical series with a 20 meter contour line) study. The Commerce Commission provided customer location data, and those locations were cross correlated with dwellings as indicated on the maps. Suitable elevated wireless node

[8] Determination for TSO Instrument for Local Residential Service for period between 1 July 2002 and 30 June 2003

locations were tested for feasibility of providing service to customer locations, then visually checking for line of sight[9] paths to the customer locations.

Gibson Quai - AAS used digital terrain data for the Napier-Taupo region, supplemented with 1:50,000 topographical series maps, to carry out a preliminary design. In this way, a more realistic assessment of the wireless models could be conducted.

A computer tool (Pathloss 4.0) was used in conjunction with the digital terrain data to evaluate wireless paths, wireless area coverage and to aid the selection of suitable network designs.

The following wireless parameters and related assumptions were applied:

a) Airspan series 4000 wireless equipment, as indicative equipment available in 2002 and subsequent years.

b) Frequency plan nominally in the 3.4 GHz band.

c) Based on manufacturers' information, the maximum traffic capacity of a channel was calculated to be 21.5 E which assumes 64kbit/s PCM encoding. This was used to calculate the number of channels required to support the actual voice and data traffic for all customers serviced by each base. Part of the Airspan Networks AS4020 Specification sheet is reproduced below.

Voice Features

Codec	64k PCM, 32k ADPCM voice coding V92/90 modem and fax support
Voice Capacity	36 Erlangs per 3.0/3.5 Mhz RF Channel (with 32k ADPCM)
Signalling	V5.2/5.1, CAS and Gr-303 switch interfaces
Services	Tranparent Class service support including CLI, support for payphones (12/16 Khz)
Latency	< 1ms (64k PCM) , 5ms(32k PCM)

Table 8-1 Part of Airspan Networks AS4020 Specification

d) The maximum number of customers per channel was assumed to be 340.

e) Per customer traffic was assessed to be the sum of the actual voice and data traffic.

f) BH traffic per line was assumed to be 1/72 * weekly traffic.

g) Path lengths in rural areas up to 25 km, though most path lengths were less than 10km while urban areas average path was up to 2.5 km.

[9] The term "line of sight" used in this report should be interpreted as the straight line between the antenna at the base site and the antenna at the related customer premises. This line is not obstructed by the terrain between those two antennas. However, the transmission fade margin makes some allowance for potential line of sight obstruction by foliage.

h) Line of sight radio paths. Radio propagation outside of urban areas can be particularly affected by dense foliage. In urban areas non-line of sight propagation is possible, but statistically difficult to model, so roof top antennas have been modelled giving an improved likelihood of line of sight radio transmission.

i) Four types of customer premises equipment (CPE) configuration:

1. Antenna on the dwelling roof top, small equipment enclosure, radio equipment, battery backed up power supply and minor cabling.
2. Antenna on a 10 m pole, weatherproof equipment enclosure, radio equipment, battery backed up power supply and minor cabling.
3. Antenna on a guyed mast or pole (30 m), weatherproof equipment enclosure, radio equipment, battery backed up power supply and minor cabling.
4. Cabled service extended up to 300 m from a wireless service (because alternative wireless service was impractical due to complex topography), small termination enclosure and minor cabling.

j) Four types of wireless node (repeater) sites:

A. Existing wireless site on an elevated location including site rental and a radio shelter.

B. New wireless site with 60 m mast, new radio shelter, power supply and land costs. For this site provision of 240 V mains power is also costed.

C. New wireless site with 90 m mast, new radio shelter, power supply and land costs. For this site provision of 240 V mains power is also costed.

E. New wireless site with 30 m mast, new radio shelter, power supply and land costs. For this site provision of 240 V mains power is also costed.

Note:

The wireless repeater sites for point to multi point does not include type D sites. This has been done to maintain uniformity of Base Site (repeater) types through out all of the technologies.

k) Two types of radio equipment:

1. Radio equipment supporting one channel which includes an omnidirectional antenna, power supply, interface equipment, installation testing and acceptance.
2. Radio equipment supporting two channels which includes two directional antennas, power supply, interface equipment, installation testing and acceptance.

l) Three types of microwave equipment for links between sites:

A. High capacity, 155 Mbit/s. These are assumed where tandem and multiple spur links are dependent on the link.

B. Medium capacity, 34 Mbit/s.

C. Low capacity digital links, N*2 Mbit/s. These are assumed on the last link (i.e. terminal links) to a node.

9. GSM MODEL

The GSM model calculates the customer cost of providing TSO services over a GSM network. The network is designed for the same ESAs as the point–to–multipoint wireless access model described in Section 8.

As with the point–to–multipoint model, the design takes topology and customer distribution into account, however differences in network design are encountered due to the characteristics of GSM.

The GSM network design is based on a centralised switching architecture, with two central Mobile Switching Centres (MSC), one is located in Wellington (North Island) and the other in Christchurch (South Island). These MSC's are connected to a small number of Base Station Controllers (BSC) and a large number of Base Transceiver Stations (BTS). The Commission's costed model is based on a subset of the network design. It has assumed that service can be incrementally provided to customers from the ESA exchanges via GSM technology. The cost structure captured in the modelling is that portion of the network that would be used to provide this 'local access' service.

Total installed costing is based on a major network rollout using a greenfields approach where new BTS sites are established in each ESA, and each BTS is dimensioned to provide TSO services for all customers in their respective capture areas such that TSO services are provided to all customers in each of the nominated ESAs.

9.1 ASSUMPTIONS

9.1.1 Customer Premises Equipment (CPE)

Three types of customer premises equipment were chosen for the GSM model. There is no option for cabling between CPE, as this is not possible with the GSM solution.

a) Customers within 5 km of a base station. These customers use a small internal whip antenna.

b) Customers between 5 km and 10 km of a base require a roof mounted antenna, installed with line of sight to the base station.

c) Customers greater than 10 km from a base station require a 10 m pole mounted antenna, with line of sight of the base station.

Customer Site Type	Description
A	Consists of a GSM fixed unit with SIM card and a small antenna mounted indoors. This will provide a car kit type performance. Interfaces are provided for standard analogue phone/fax equipment and a 14.4kbit/s modem. This customer type equipment will be used within 5 km of a base station and may support non-line of site communications due to relatively high signal strengths. Although multi-path interference could be an issue for non-line of sight communications this would be mitigated against through the use of a fixed mobile unit with car kit performance and it is assumed that the installer would select a fixed position which is not subject to multi-path interference. Furthermore in most cases these units would have visibility of more than one base enabling more opportunity for line of sight propagation and choice for optimum received signal levels from more than one base.
B	Consists of the same indoor unit as Type A, but with a roof mounted antenna and extra cabling requirements. This customer type equipment will generally be used for customers between 5 km and 10 km of a base where the land is reasonably flat and line of site to the base station is possible. However in hilly or mountainous areas customer sites within 5 km and 10 km of a base may require an elevated antenna, customer site type C, in order to maintain line of site communications.
C	Consists of the same indoor unit as Type A, but with an antenna mounted on a 10 m pole. This customer type equipment will generally be used for customers greater than 10 km from a base station and is required to provide line of sight to the base station.

Table 9-1: Customer premises equipment types.

9.1.2 GSM Base Sites

The GSM access model includes four different base site options.

GSM Base Site Type	Description
A	Base site where an existing tower or mast exists. Includes costs for site rental and radio shelter.
B	New site where a 60 m mast is required. Includes land, preplanning surveys, shelter, the radio mast and connection of 240 V mains power to the site.
C	New site where a 90 m mast is required. A 90 m mast may be required where many services are to be mounted at the same site. Apart from the mast this site includes the same equipment as Type B.
D	This GSM base site is used in large towns or cities, where the antennas can be mounted on the outside of a building. There is no requirement for a large tower or mast because of high population density and correspondingly smaller geographic cell sizes. Includes costs for shelter and site rental and assumes that 240V power is available to the site.
E	New site where a 30 m mast is required. Includes land, preplanning surveys, shelter, the radio mast and connection of 240 V mains power to the site..

Table 9-2: GSM Base Site types.

9.1.3 GSM Base Equipment (BTS/BSC)

The model uses three base equipment categories to cover areas of different customer distribution. The base equipment costs include the GSM Base Transceiver Station (BTS), Base Station Controller (BSC), antennas and feeders, interface equipment, power supply, installation and commissioning.

A BTS houses the radio transceivers that provide communications with the GSM fixed GSM units at the customer premises. The BSC manages radio resources and features like handover, for one or more BTSs, and communicates with the Mobile Switching Centre (MSC). Thus in the model there are 0.1 BSCs per GSM base (BTS) site.

Customer coverage and dimensioning of BTS equipment is based on the following assumptions:

a) Coverage from BTS to meet the TSO equivalent fixed telephone line performance, which is more stringent than mobile commercial performance.

b) The map study methodology elaborated earlier in section 8.1.1 was applied with an objective of providing line of sight communications to as many customers as possible within the ESA. Fade Margins between 15 and 40 dB were assumed to account for potential path attenuation loss due to Rayleigh fade, interference margin, and provision for path attenuation less than the free space loss.

c) Customers require 1 timeslot per circuit for voice. The time slot will be dedicated to the voice call for the duration of the call.

d) To calculate the number of timeslots for data traffic over GPRS we used the following equation:

Number of GPRS Timeslots = [
] / (9.6×3600)

Where Y % = 50 % internet traffic utilization

The dimensioning assumes that a GPRS timeslot can be shared between multiple customers at the same time. The network will dynamically allocate the required number of timeslots to allow users to send the data when required. Therefore, to calculate the number of GPRS timeslots required, it was necessary to calculate the amount of data required by all the customer during the busy hour, multiply that by 14.4kbits/s to get the total amount of data transmitted in the busy hour and divide by 9.6kbits/s (the data rate capability of one GPRS timeslot) yielding in the number of GPRS timeslots required. Then divide by 3600 secs (1 hour) to get the instantaneous demand of the busy hour volume calculated.

Note:

This formula will calculate the required number of time slots for a data throughput of 14.4kbit/s. To calculate the number of traffic dependant devices at each BTS we have used this formula in conjunction with actual traffic data per line which has been measured in minutes per line per year. However the actual traffic per line is probably measured from dial up services which are operating at speeds greater than 14.4kbit/s (between 19.2 and 56kbit/s). We have no information relating to what those actual speeds might be. The application of the average actual data speed to this model would increase the total number of traffic dependant devices required (assuming it to be greater than 14.4kbit/s). However if customers data speeds were limited to 14.4kbit/s then we consider it unlikely that the actual data throughput would be as high as it would be if they had access to higher speeds. Therefore given the above we have assumed that the actual traffic data per line is equivalent to what it would be if the data speed was 14.4kbit/s.

e) A 20% increase in the number of GPRS timeslots required was applied to cater for peak surges

f) Busy hour voice and data traffic was calculated from actual ESA annual traffic figures (minutes per line per year) for each of the modelled years using the following parameters:

   a. 52 weeks a year;
   b. 72 busy hours a week;
   c. 60 seconds per minute;
   d. Number of lines per ESA.

   Traffic data for year 2005 - 2006 was not supplied therefore 2004 – 2005 data was used.

g) Busy hour traffic capacity was calculated for a Grade of service of P=0.01

h) Availability of the whole 128 GSM channels.

i) Maximum capacity calculation through the addition of voice and data traffic.

j) Capacity independence was maintained between ESAs so that the traffic dependant GSM equipment for each ESA was dimensioned to carry all customer traffic for that ESA.

Each BTS transmitter has 8 timeslots; first transmitter in a cell contains a BCCH timeslot (Broadcast Control Channel) and an SDCCH (Standalone Dedicated Control Channel). Each subsequent transmitter on a cell will require an SDCCH channel. Therefore a BTS with 6 transmitters will have 48 timeslots (1 × BCCH, 6 × SDCCH, and 41 × voice/GPRS).

Note: the 14.4 kbit/s circuit switched timeslots have been available in GSM network for a while, but this system was very unreliable and hence was never used by carriers in Australia. Although the system is capable of 14.4kbit/s. this speed is only possible in a location with no errors on the radio link between the base station to the phone (which is very rare as radio links, by nature, are prone to at least some errors), by nature, In the majority cases, a data throughput of much less than 14.4kbit/s is achievable. This is because the error correction in a 14.4kbit/s data stream is very limited, so just a few errors in the data will mean that the system will need to re-transmit the data, which slows the throughput down considerably. GPRS on the other hand has a lot more error correction added to it by the network, and hence is a lot more immune to errors on the radio link. Although the maximum throughput of a single GPRS timeslot is 9.6kbit/s (compared to the 14.4kbit/s of the circuit switched data), the average throughput of a GPRS timeslot is much higher than the circuit switched data. Hence for the purpose of this design we have assumed that the TSO data model is based on GPRS.

Based on the above assumptions the following GSM Base Equipment modules types were used in the models.

Base Equipment Type	Description
1	High capacity BTS with 12 transceivers, for use in high density areas. This BTS can handle 12 × 8 = 96 timeslots. (1 ×BCCH, 12 ×SDCCH, 83 × voice/GPRS traffic)
2	Medium capacity BTS with 6 transceivers for use on medium density areas. This BTS can handle 6 × 8 = 48 timeslots. (1 ×BCCH, 6 ×SDCCH, 41 × voice/GPRS traffic)
3	Low capacity BTS with 3 transceivers for use in low density areas. This BTS can handle3 × 8 timeslots= 24 (1 ×BCCH, 3 ×SDCCH, 20 × voice/GPRS traffic)

Table 9-3: GSM Base Equipment types.

9.1.4 Radio Link Equipment

Three radio link options of different capacity are modelled. These links are used to interconnect base sites, and also to provide backhaul capacity to the relevant ESA exchange.

Each link is chosen according to the traffic carrying requirements and costed for radio equipment, antennas/feeders, power supply, planning, design, installation, commissioning and acceptance.

The link types chosen for this model are of the same capacity and cost as the point –to–multipoint model. The following table summaries the link type and capacity.

Radio Link Type	Description
A	High capacity backhaul link equipment. Capacity of the order of 155 Mbit/s.
B	Medium capacity backhaul link equipment. Capacity of the order of 34 Mbit/s.
C	Low capacity backhaul link equipment. Capacity of the order of N x 2 Mbit/s.

Table 9-4: Radio Link equipment types.

9.1.5 Backhaul

The cost of voice and data traffic backhaul from each ESA to the relevant MSC was calculated using LRIC unit costs were derived from Commerce Commission data (HCPM 03 04 using CPNZ 2.2, July to June). This was combined with modelled traffic data in minutes per line per year to provide an allowance for recovering the traffic related costs associated with Telecom's PSTN operation.

9.1.6 Core

The modelling approach employed used the LRIC costs advised by the Commission. These LRIC costs incorporate the PSTN network's core costs. Hence, it has not been necessary to model core network elements such as MSC, HRL and various licence fees.

9.2 ESA DESIGN

Specific ESA coverage designs using GSM access have been prepared for the nominated ESAs during the relevant years in the following areas:

- Timaru
- Hinds
- Waimarama
- Patoka and Te Pohue

These designs are illustrated by the following schematic diagrams.

9.2.1 Timaru

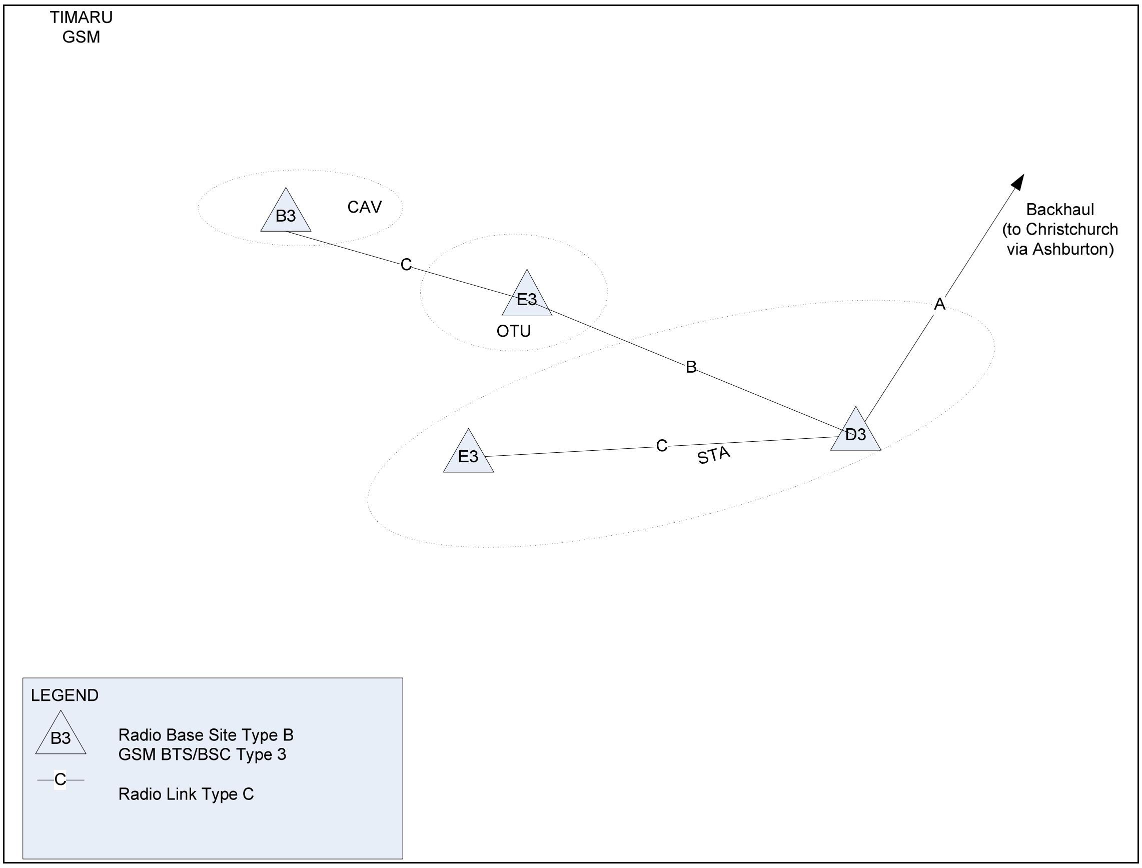

Figure 9.1: Network design schematic for Timaru ESAs.

The following table contains approximate coordinates (New Zealand Map Projection Geodatic Datumn 1949) for the selected base sites in the Timaru region:

Site	Easting	Northing
CAV B3	2,351,150	5,646,250
OTU E3	2,357,075	5,637,325
STA D3	2,366,175	5,629,200
STA E3	2,350,800	5,230,300

Table 9-5 Timaru region approximate site coordinates

9.2.2 Hinds

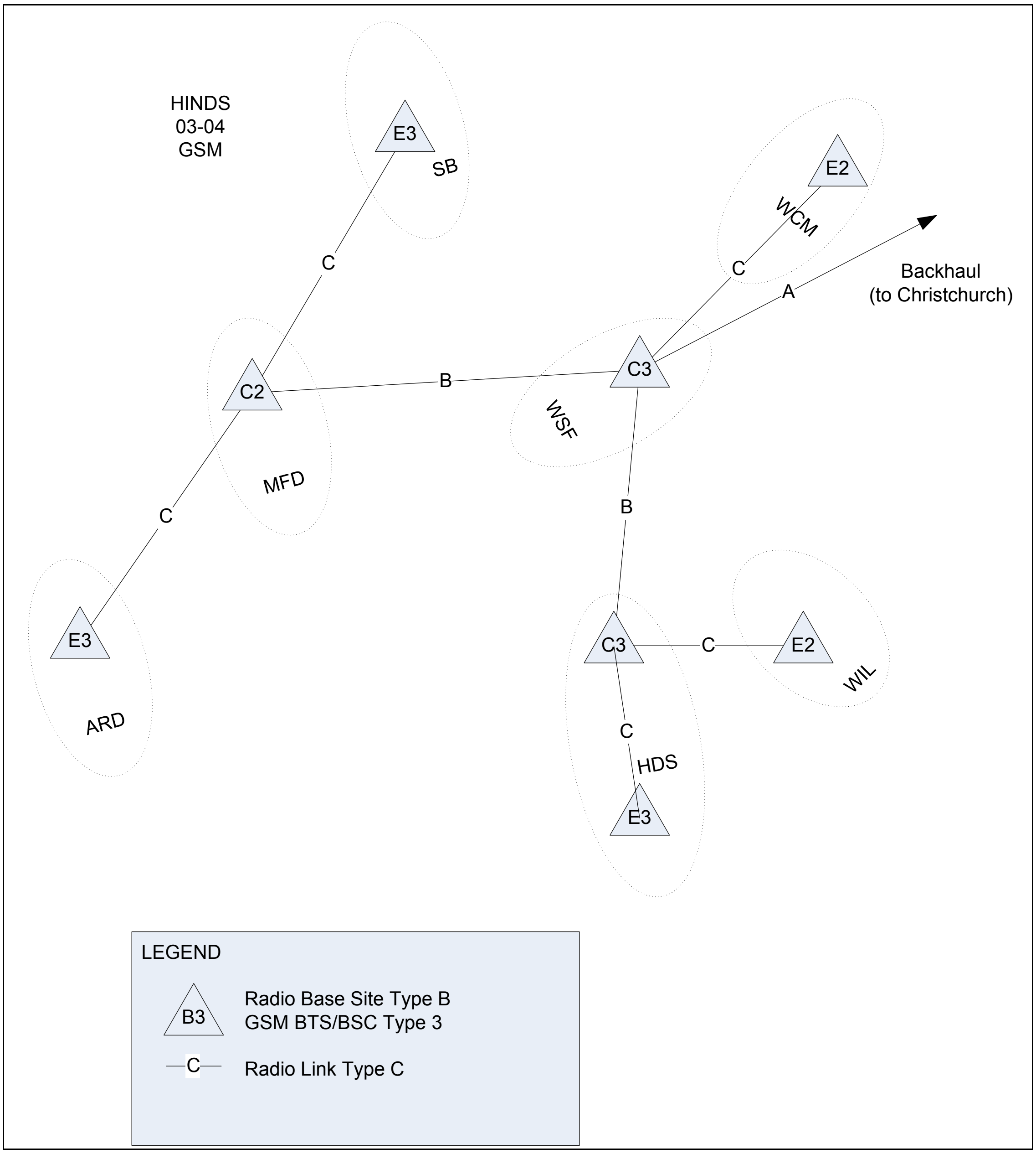

Figure 9.2: Network design schematic for Hinds ESAs.

The following table contains approximate coordinates (New Zealand Map Projection Geodatic Datumn 1949) for the selected base sites in the Hinds[10] region:

Site	Easting	Northing
SB E3	2,386,050	5,727,900

[10] This area was flat and hence site selection was substantially based around circles of coverage which picked up all the customers within the ESA.

MFD C2	2,386,050	5,709,400
ARD E3	2,374,050	5,690,825
WCM E2	2,407,550	5,725,250
WSF C3	2,402,050	5,706,150
HDS C3	2,394,700	5,687,700
HDS B3	2,397,125	5,674,700
WIL E2	2,405,300	5,690,000

Table 9-6 Hinds region approximate sites coordinates

9.2.3 Waimarama

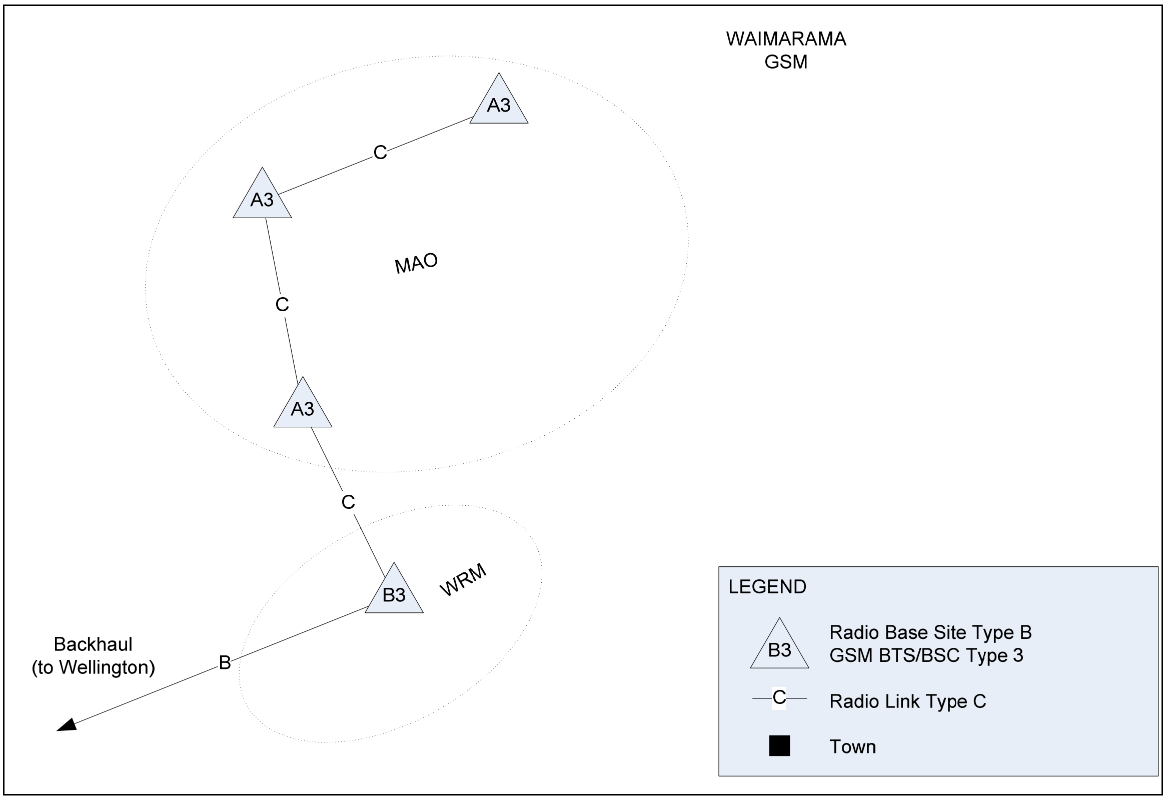

Figure 9.3: Network design for Waimarama ESAs.

The following table contains approximate coordinates (New Zealand Map Projection Geodatic Datumn 1949) for the selected base sites in the Waimarama region:

Site	Easting	Northing
MAO A3 1[11]	2,845,200	6,159,875
MAO A3 2	2,839,150	6,155,750
MAO A3 3	2,841,490	6,149,500
WRM B3	2,844,150	6,146,225

[11] The sites of the MAO ESA where numbered in a counter clockwise manner starting from the top right corner A3 site.

Table 9-7 Waimarama region approximate sites coordinates

9.2.4 Patoka and Te Pohue

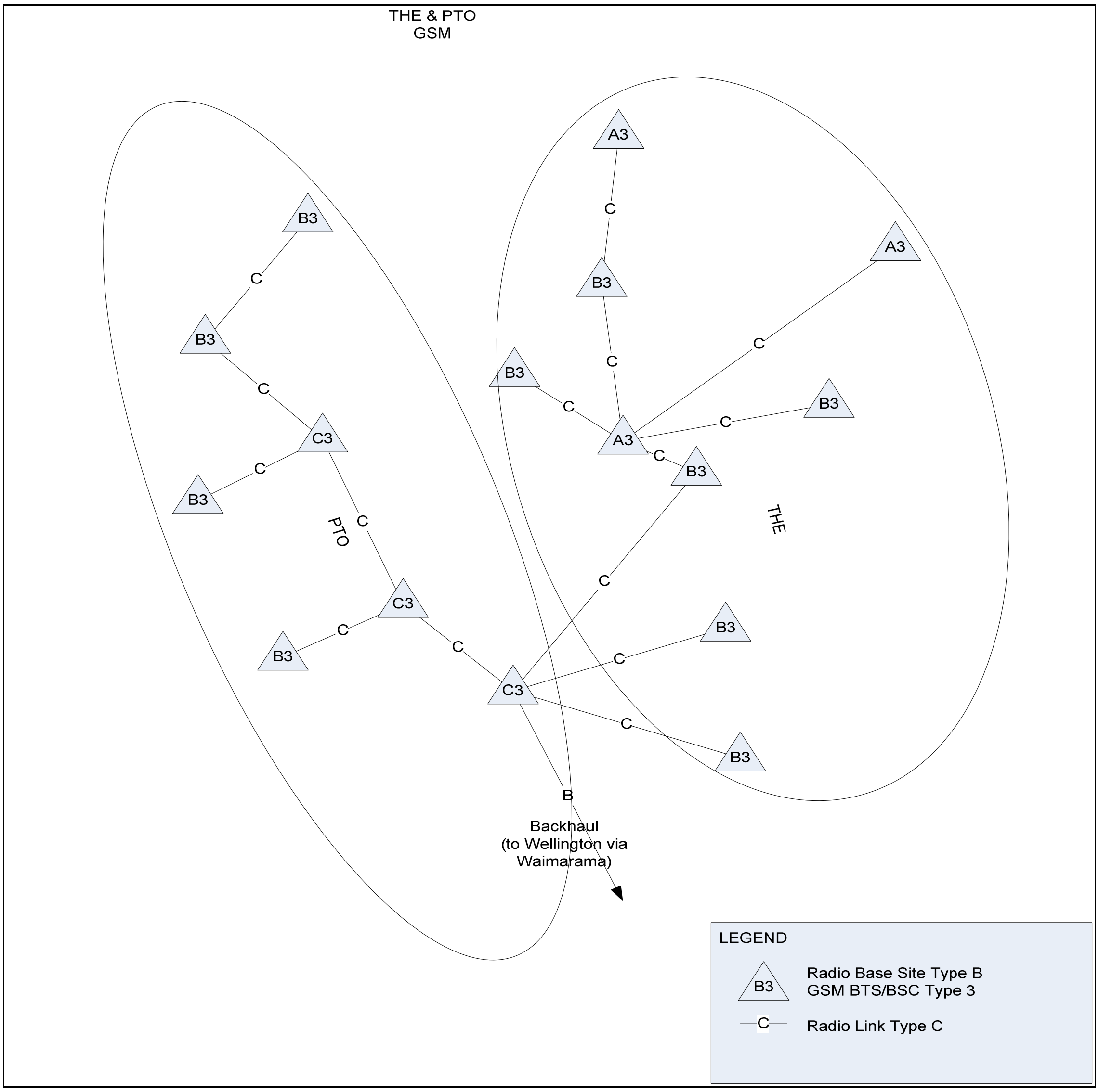

Figure 9.4: Network design for THE and PTO ESAs.

The following table contains approximate coordinates (New Zealand Map Projection Geodatic Datumn 1949) for the selected sites in the Patoka and Te Pohue regions:

Site	Easting	Northing
PTO B3 1[12]	2,812,900	6,219,700
PTO B3 2	2,811,675	6,214,100
PTO C3 3	2,815,800	6,211,600
PTO B3 4	2,811,750	6,207,675
PTO C3 5	2,820,275	6,201,950

[12] The sites of the PTO ESA where numbered from top to bottom , right to left .

PTO B3 6	2,815,000	6,197,350
PTO C3 7	2,826,350	6,200,100
THE A3 1[13]	2,831,775	6,228,700
THE A3 2	2,833,250	6,223,375
THE B3 3	2,821,850	6,223,275
THE B3 4	2,821,000	6,218,700
THE B3 5	2,832,925	6,214,075
THE A3 6	2.825,725	6,213,100
THE B3 7	2,828,625	6,211,200
THE B3 8	2,830,900	6,203,650
THE B3 9	2,833,425	6,193,625

Table 9-8 Patoka and Te Pohue regions approximate sites coordinates

10. CDMA MODEL

The CDMA model was developed using a similar methodology to the GSM model, and many of the components are essentially the same. Base equipment was generally placed at the same sites as in the GSM model, and costs for these sites and inter-site links are the same.

The difference in protocol raises some issues with dimensioning of CDMA base equipment. Multiple-access in a GSM network is based on Time Division Multiple Access (TDMA), hence base equipment capacity is limited by the available timeslots. CDMA (Code Division Multiple Access) systems utilise spread spectrum techniques, where the signal to each mobile station shares the same bandwidth but is separated by coding.

Each CDMA user is given a unique binary sequence, called a PN (Pseudo Noise) code. In the transmitter the binary message signal of a user is modulated onto a carrier and then multiplied by the user's PN code. PN codes have much smaller bit durations than that of the message signal. Therefore, the transmitted signal is spread over a larger bandwidth than it will normally occupy. Message recovery involves decompressing the signal, which can be achieved by multiplying the received signal by the correct PN code.

The implication of this is that CDMA base equipment capacity is interference limited, so a group of base sites close together will interfere with each other and decrease overall capacity. On the other hand a base site in a remote area with few neighbouring base sites will have a higher capacity.

Another important difference is the range of coverage compared to a GSM network. GSM is limited to approximately 35 km (unless the extended cell feature is used) because of timeslot synchronisation issues, whereas the code division in a CDMA network will support good communication over a much larger range provided sufficient Eb/Lo(energy per bit to interference ratio) is available.

These factors are taken into account through a range of assumptions that are detailed in the next section.

[13] The sites of the THE ESA where numbered from top to bottom , right to left

10.1 ASSUMPTIONS

10.1.1 Customer Premises Equipment (CPE)

The only difference between CPE for the GSM and CDMA models is the fixed unit used in each model. The CDMA fixed unit is slightly more expensive based on data available to Gibson Quai - AAS. The same distribution of CPE types is used for both models, as the radio propagation characteristics of both networks is the similar, and the same base sites are used.

CDMA CPE Type	Description
A	Consists of a CDMA fixed unit card and a small antenna mounted indoors. This will provide a car kit type performance Interfaces are provided for standard analogue phone/fax equipment and a 14.4kbit/s modem. This customer type equipment will be used within 5 km of a base station and may support non-line of site communications due to relatively high signal strengths. Although multi-path interference could be an issue for non-line of sight communications this would be mitigated against through the use of a fixed mobile unit with car kit performance and it is assumed that the installer would select a fixed position which is not subject to multi-path interference. Furthermore in most cases these units would have visibility of more than one base enabling more opportunity for line of sight propagation and choice for optimum received signal levels from more than one base.
B	Consists of the same indoor unit as Type A, but with a roof mounted antenna and extra cabling requirements. This customer type equipment will generally be used for customers between 5 km and 10 km of a base where the land is reasonably flat and line of site to the base station is possible. However in hilly or mountainous areas customer sites within 5 km and 10 km of a base may require an elevated antenna, customer site type C, in order to maintain line of site communications.
C	Consists of the same indoor unit as Type A, but with an antenna mounted on a 10 m pole. This customer type equipment will generally be used for customers greater than 10 km from a base station and is required to provide line of sight to the base station.

Table 10-1: CDMA customer premises equipment.

10.1.2 CDMA Base Sites (Tower/Mast)

The CDMA model uses the same Base Site types as the GSM model. See Section 9.1.2.

10.1.3 CDMA Base Stations (Node Bs)

The model uses two categories of Node B's one is a high capacity sectorised type and the other is a low capacity omnidirectional type.

The CDMA network has devices called Radio Network Controllers (RNCs) which are similar to the GSM Base Station Controller, which controls base station handover and other functions. The model assumes that there are 0.1 Node B's per RNC

Customer coverage of Node B equipment is calculated through the application of the following assumptions:

k) CDMA capacity calculations are in terms of the number of users, or equivalently, the number of traffic channels; can be found from the following equation:

$$L \approx 1 + [G / (\alpha (1 + k) \Gamma)]$$

Where:

L = Number of traffic channels.

G = Processing gain G=128 for voice (9.6kbps) and G=85 for data (14.4kbps)

α = Voice activity factor (= 0.4 based upon measurements by Bell Laboratories) and α = 0.5 for data

k = Intercell interference factor (k=0 for single cell and k=0.6 for multicell systems).

Γ = Target value of E_b/I_0. (Typically a target value of 7 is used to ensure that the BER is kept below 10^{-3} however it is dependent on the coding and modulation scheme used).

l) A 10% capacity capability de-rating rate was applied.

m) A further 15% capacity capability de-rating rate was applied to multi sector Node Bs due to efficiency drop.

n) Busy hour voice and data traffic was calculated from actual ESA annual traffic figures (minutes per line per year) for each of the modelled years using the following parameters:

   a. 52 weeks a year;
   b. 72 busy hours a week;
   c. 60 seconds per minute;
   d. Number of lines per ESA.

   Traffic data for year 2005 - 2006 was not supplied therefore 2004 – 2005 data was used.

o) Busy hour traffic capacity was calculated for a Grade of service of P=0.01

p) Maximum capacity was calculated through the addition of voice and data traffic.

q) Capacity independence was maintained between ESAs so that the traffic dependant CDMA equipment for each ESA was dimensioned to carry all customer traffic for that ESA.

Based on the above assumptions the following CDMA Base Station equipment types were used in the models.

Type	Description
Sectorised	High capacity base station for use in high teledensity areas. This base station has three sectors (3 directional antennas) and supports 67 active voice users or 37 active data users.
Omnidirectional	Low capacity base station for use of low density areas. This base station has one omnidirectional antenna and supports 42 active voice users or 22 active data users.

Table 10-2: CDMA Base Station equipment.

10.1.4 Radio Link Equipment

The CDMA model uses the same Radio Link types as the GSM model. See Section 9.1.4.

10.1.5 Backhaul

The backhaul requirements for CDMA remain the same as for the GSM network as the same customer assumptions are used. The Commission's cost model is based on a subset of the network design. It has assumed that service can be incrementally provided to customers from the ESA exchanges via GSM technology. The cost structure captured in the modelling is that portion of the network that would be used to provide this 'local access' service.

LRIC unit costs were derived from Commerce Commission data (HCPM 03 04 using CPNZ 2.2, July to June). This was combined with modelled traffic data in minutes per line per year to provide an allowance for recovering the traffic related costs associated with Telecom's PSTN operation.

10.1.6 Core

The modelling approach employed used the LRIC costs advised by the Commission. These LRIC costs incorporate the PSTN network's core costs. Hence It has not been necessary to model core network elements such as: MSC, HRL and various licence fees.

10.1.7 Costs

Site costs such as towers, shelters and power supplies are the same as for the GSM model. Cost differences between GSM and CDMA exist mainly in the base equipment and CPE. Gibson Quai - AAS has made the following assumptions:

- CDMA base equipment is approximately 15% more expensive than GSM equipment of similar capacity. This is based on information from service providers in Australia and our experience with this technology;

11. RESULTS

The application of the design principals and assumptions as discussed above resulted in the calculation of average cost per customer for wireless based access in their respective ESA.

Annualised and net present value results are presented for each of the three years modelled, for each ESA.

11.1 2003 – 2004 ANNUALISED

[ ]

Table 11-1: Annualised cost per customer of wireless access to TSO services for the year 2003 – 2004 (CCRI).

11.2 2004 – 2005 ANNUALISED

[ ]

Table 11-2: Annualised cost per customer of wireless access to TSO services for the year 2004 – 2005 (CCRI).

11.3 2005 – 2006 ANNUALISED

[ ]

Table 11-3: Annualised cost per customer of wireless access to TSO services for the year 2005 – 2006 (CCRI).

11.4 2003 – 2004 NPV (INFINITY)

[ ]

Table 11-4: NPV (infinity) per customer of wireless access to TSO services for the year 2003 – 2004 (CCRI).

11.5 2004 – 2005 NPV (INFINITY)

[ ]

Table 11-5: NPV (infinity) per customer of wireless access to TSO services for the year 2004 – 2005 (CCRI).

11.6 2005 – 2006 NPV (INFINITY)

[ ]

Table 11-6: NPV (infinity) per customer of wireless access to TSO services for the year 2005 – 2006 (CCRI).

A. GLOSSARY OF TERMS

3G	3rd Generation mobile phone technology
AMPS	Advanced Mobile Phone System
bhE	Busy hour Erlangs
BSC	Base Controller Station
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CNVCs	Commercially Non-Viable Customers
DAMPS	Digital Advanced Mobile Phone System
DMR	Digital Microwave Radio
ESA	Exchange Service Area
GEO	Geostationary Earth Orbit
GSM	Global System for Mobile communications
HLR	Home Location Register
LEO	Low Earth Orbit
LMDS	Local Multipoint Distribution Service. Short range wireless broadband access technology, operating in bands higher than 20 GHz.
LRIC	Long Run Incremental Cost
mE	milli-Erlang
MEA	Mean Equivalent Asset
MEO	Medium Earth Orbit
MMDS	Multichannel Multipoint Distribution Service. Wireless broadband access technology operating in the 2 – 3 GHz band typically used for television.
MSC	Mobile Switching Centre
P-mp	Point to multipoint
PN	Pseudo Noise
PoP	Point of Presence
SDH	Synchronous Digital Hierarchy
TDMA	Time Division Multiple Access
TNZ	Telecom New Zealand

TSO	Telecommunications Service Obligation