"What effect would different price point choices have on achieving the objectives mentioned in s 18, the promotion of competition for the long-term benefit of end-users, the efficiencies in the sector, and incentives to innovate that exist for, and the risks faced by investors in new telecommunications services that involve significant capital investment and that offer capabilities not available from established services?"

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Executive Summary

1. The approach taken to answer the question in the title is based on an error analysis. Accordingly, first the question is addressed what the consequences in terms of achieving the s 18 objectives are of setting the UBA price above or below its true cost (in terms of an exact TSLRIC measurement). The results give both the potential effects (a) of deliberately deviating from true cost and (b) of errors in measuring the true cost. The following section addresses the likely errors in measurement, given the Commission's observations of benchmark countries. This section is concerned with the expected value of UBA costs to be derived from the evidence presented as well as a crude assessment of the probability distribution around the expected value. It also pulls together the error consequences for achieving the s 18 objectives, trying to minimize the negative consequences of errors. It is obvious that my analysis cannot provide a precise "true" cost figure but it can give a good sense of the range, where the true cost is likely to be.

2. While no submissions or cross-submissions in this pricing review call for a decrease in UBA price compared to the Commission's Draft Determination and while several of them call for an increase, we have to analyze the effects of both an increase and a decrease in the UBA price compared to the true UBA cost on the objectives of s 18, because we do not know what the true UBA cost is. In doing so we assume that the resulting price will nevertheless be well below the current UBA price.

3. We expect that an increase (decrease) in the UBA price relative to the true UBA cost will lead to a price increase (decrease) for final consumers, but that this effect is dampened by additional (reduced) competition, in particular from unbundling. This dampening effect, however, will be stronger for UBA price increases than for price reductions.

4. The effects on innovation of a price increase (decrease) is positive (negative) in the sense that all substitutes of UBA see their prices or expected penetration (at fixed prices) rise (fall). This holds for UFB in particular, but also extends to Chorus' commercially offered copper-based products, such as VDSL. However, all these effects on innovation are dampened by the competitive interaction that works for the static benefits as described above. Given the subsidies provided for UFB investments (including the high UBA price for Chorus until end of 2014) and the

contracts the UFB investors entered into, the positive (negative) effects on innovation will be substantially smaller than otherwise. At the end, any migration effect has to be balanced against the negative (positive) effect such higher (lower) UBA charges have on consumers of UBA-based services. In particular, the negative (positive) effects of higher (lower) UBA charges on the LTBEU of UBA-based services accrue for a long time even for those users that ultimately switch to UFB and forever for those users not willing or able to switch.

5. The evidence suggests that deviations from true costs pose tradeoffs. There is no reason for a surcharge on cost based on ladder-of-investment arguments. An increase in the UBA price may incentivize innovations and buffer risks of the investments associated with such innovations. In addition, spillovers from additional UFB subscriptions in the form of network effects on new applications that directly benefit the UFB subscribers may justify higher UBA prices than true UBA costs. However, to the extent that an increase in the UBA price is dampened by competitive effects it will also be less helpful in triggering innovation. One cannot have it both, no adverse effects on the LTBEU of copper-based products and positive effects on innovation and penetration of UFB. Conversely, because of a smaller dampening effect a UBA price reduction below the true UBA cost will have stronger negative effects on UFB penetration and investment risk. Overall, at this point of the analysis an increase of the UBA price compared to true cost appears to be justified, while a decrease may be outright harmful. However, so far we have not looked systematically at the effects of cost averaging and have only considered small price changes.[1]

6. While Chorus generally has an interest in high UBA charges as a price ceiling, it will want to have the option selectively to lower the price to meet competition. Regulated UBA charges at the geographically averaged TSLRIC will be significantly above the weighted average of true costs in areas where Chorus invests in UFB, will be close to the weighted average of true cost in LFC areas and will be below average true cost in rural areas without UFB. As a result, geographic averaging of TSLRIC costs will already achieve some compromise between setting prices above true costs in order to incentivize innovations and reduce investment risks and acting in the LTBEU in areas that will not be served by UFB.

7. We then turn to large price changes. While for a large UBA price increase the violation of the s 18 objectives may be substantial, particularly in rural areas, it will be much larger for a large price decrease, because that jeopardizes Chorus' and to some extent the LFCs' ability to make UFB investments.

8. Because of higher population density Denmark has lower UBA cost than Sweden. In addition, since New Zealand's density is very close to that of Sweden the Swedish observation is probably much closer to the true expected value of UBA cost for New Zealand than the Danish observation. Consequently, a value at the 75% or even the 100% mark between the benchmark costs of Denmark and Sweden appears to be justified.

9. While neither we nor the Commission can actually estimate the error distribution or the error costs, the conceptual exercise done in this paper helps in providing the direction of the optimal price from the expected value of the distribution. It is clearly above the expected value.

[1] In this context, price changes up to 10% can be considered "small".

Furthermore, the analysis helps limit the amount, by which the optimal value will exceed the expected value.

10. In conclusion, while the objectives of s 18 and s 19 are fulfilled by a price certainly not below but possibly above true costs, the error analysis indicates that the price should clearly be above expected costs. Furthermore, the expected value of Chorus' UBA costs appears to be above the median between the UBA cost of Denmark and Sweden. Combining these factors justifies a UBA price at the measured UBA cost of Sweden. Such a price at the 100% mark would still be compatible with a requirement to stay within the benchmarking range. In my view, it could even exceed this value. Since objective measures are not available, these statements are based on subjective probability assessments.

I. Introduction

11. I am an economics professor at Boston University with a specialization in the regulation of network industries. My work has been tightly connected with the regulation and liberalization of the telecommunications sector for about 35 years. As a German native, who lives and works in the USA, I have been naturally exposed to international issues of telecommunications regulation, and I have consulted for regulators in various countries, such as Germany, the European Commission, the Netherlands, Switzerland, Peru, and Australia. Among the policy issues I have specialized in price regulation, in the early years of end-user services and then of wholesale access. I have published widely in this area, including a survey in the Journal of Economic Literature on access pricing and co-editorship of the two volumes of the Handbook of Telecommunications Economics. I have no conflict of interest, having not worked on the issues before me now for any of the parties involved in this pricing review.

12. The Commerce Commission (Commission) has asked me to conduct an independent analysis of the key Section 18 (s 18) of the Telecommunications Act (the Act) economic considerations when undertaking a price review for the UBA services in New Zealand by answering the question in the title of this paper. For that purpose I have read as background material the Commission's Draft Determination of December 3, 2012 plus all the submissions and cross-submissions that were filed subsequently. I also read the WIK report of October 2012 in this pricing review. The Commission's staff has briefed me on the legal and market situation in the New Zealand telecommunications sector.

13. In the following, I will first in Section II summarize my understanding of the s 18 background. This will be followed by an analysis of the IPP UBA pricing issue before the Commission. The structure of the approach taken is based on an error analysis. Consequently, first and in the longest section III the question is addressed what the consequences in terms of achieving the s 18 objectives are of setting the UBA price above or below its true cost (without exactly specifying what the true cost is). We will also try to assess the differences in effects between small or large deviations from the true cost. The results of this section give both the potential effects of deliberately deviating from true cost and of errors in measuring the true cost. The following Section IV addresses the likely errors in measurement, given the Commission's observations of benchmark countries. This section is concerned with the expected value of UBA costs to be derived from the evidence presented as well as a crude assessment of the

probability distribution around the expected value. It also pulls together the error consequences for achieving the s 18 objectives with the probability distribution, trying to minimize the negative consequences of errors. It is obvious that my analysis cannot provide a precise "true" cost figure but it can give a good sense of the range, where the true cost is likely to be. Section V concludes.

II. The section 18 background

14. The current UBA pricing review concerns the initial pricing principle (IPP) to be applied to UBA. The IPP is to be based on a benchmarking analysis of other countries that apply a forward-looking cost model (s 30R of the Act). s 18 specifies considerations that the Commission has to take into account in its pricing decision. In my view, these considerations shall fill out any discretion that the Commission has in its decision making.

15. Thus, from an economic perspective the Commission's decision in this current pricing review is constrained to use the IPP method. To the extent that this constraint can be fulfilled in different ways or leaves otherwise room for discretion the choice of the Commission has to follow the considerations provided by s 18. This means that the Commission first has to determine the feasible benchmark set and the resulting range of outcomes before addressing the s 18 issues.

16. In its Determination of December 3, 2012 the Commission has found the feasible set of countries for benchmarking to consist only of Denmark and Sweden. The Commission fully realizes that this is a very small sample that does not allow for any statistical confidence tests. On the other hand, if one had to choose any two among the world's nearly 200 countries then these two would probably be the ones closest to New Zealand in many economic respects relevant for this costing analysis.

17. The set of two benchmark countries yields two cost estimates. Unless the Commission makes adjustments to these results the Commission's discretion is therefore limited to the range spun by these two cost figures. In its Draft Determination the Commission decided to take the average between these two numbers as the IPP benchmark.

18. Here the s 18 considerations come into place.

(a) s 18 first (s 18 (1)) specifies the promotion of competition in telecommunications markets for the "long-term benefit of end-users" (LTBEU) of telecommunications services as the objective of this part of the Telecommunications Act. Competition is usually considered the best means for solving the complex tradeoff between quality, price and investment to best meet consumer demand. Thus, the UBA price determination would first and foremost have the objective of promoting competition. While the promotion of competition is clear, the additional requirement "for the long-term benefit of end-users" seems to indicate that there could be (regulation-induced) competition that is not providing long-term benefits for end-users. At least this possibility would have to be checked by the Commission.

(b) s 18 (2) further specifies that any efficiencies likely to result from decisions of the Commission have to be taken into consideration. While the LTBEU only concern one side of the market, the efficiencies concern suppliers and others (like software developers) as well. Customarily the

consideration of efficiencies would therefore allow for some tradeoffs between consumers and suppliers. However, that would defeat the objective described in the previous paragraph. My view therefore is that the efficiency considerations only apply if there is more than one way to satisfy the objective of promoting competition for the long-term benefit of end-users.

(c) This is further explained in s 18 (2A), which interprets the consideration in case of doubt to apply to "the incentives to innovate that exist for, and the risks faced by, investors in new telecommunications services that involve significant capital investment and that offer capabilities not available from established services". This seems to be the most contentious part of s 18.

19. In particular, Chorus (and its advisors CEG and Sapere) want s 18 (2A) to be restricted to investments in UFB access and claim that economic analysis would dictate that the innovation incentives take full priority over any static welfare considerations. Both of these assertions are misguided. If the legislators had meant UFB investments only they could have written that into the Act. In my view, other innovative services certainly also could qualify even though those based on UFB investments may be the most important ones.

20. Chorus and its advisors have a somewhat different view of economics than the current author. My view is that any policy decisions with any discretion involve tradeoffs. In fact, I view "tradeoff" as the key word that defines the economic discipline. In contrast, Chorus and its advisors use a so-called lexicographic ordering, according to which other objectives only come to bear if a prime objective has been fully satisfied. Applied to the claimed priority of innovation over static efficiency the tradeoff approach means that the costs in allocative efficiency imposed by an increase in innovation has to be compared to the benefits provided by the innovation. It then is a property of the optimal policy that the additional costs in terms of allocative efficiency just equal the additional benefits from innovation.

21. Chorus' assertion of priority of innovation over static efficiency could even justify unregulated monopoly prices. However, it is well known that at the monopoly price the static consumer gains from a price reduction are significant (first order), while the profit loss is minimal (second order).[2] In the neighborhood of the monopoly price the incentive increase for innovation is therefore small relative to the static consumer benefits that would be lost.

III. The consequences for s 18 objectives of deviating from the true UBA cost

Assessing the effects of a (small) price increase or price decrease relative to the true UBA cost

22. While no submissions or cross-submissions in this pricing review call for a decrease in UBA price compared to the Commission's Draft Determination and while several of them call for an increase, we have to analyze the effects of both an increase and a decrease in the UBA price compared to the true UBA cost on the objectives of s 18, because we do not know what the true UBA cost is. Would a (obviously not too large) increase above this price better serve the objectives of s 18 and s 19? This analysis is done with full certainty about the true costs of UBA in New Zealand. In this section we therefore hypothetically assume that the true UBA cost is known. What we term the true UBA cost is the TSLRIC that would result from a perfect costing

[2] By definition the derivative of profit with respect to price is zero at the profit maximum.

analysis. We will below characterize some of the properties of this cost measure. Since the analysis in this section would hold for any true estimate of the costs of UBA in New Zealand, it would just as well hold for the final pricing principle (FPP), should such an analysis be requested by any of the parties involved.

23. While we do not attempt to determine the true UBA cost at this stage, we assume that it is substantially below the current UBA price (delta) of NZ$21.46 per month. This is clear from all the evidence presented in this pricing review and conforms to my prior knowledge from other areas of the world. The analysis of a (small) price increase in UBA therefore needs to be seen before the background of a potentially very large reduction of the UBA price relative to the status quo that will nevertheless occur under the IPP. This is important because the New Zealand Government has indicated that it would pursue a change in the Act if the Draft Determination is implemented. A one-time reduction in a regulated price of the magnitude proposed in the Draft Determination would mean that the previous price imposed little or no constraint on the regulated firm.[3] While this may be true for the New Zealand situation of UBA pricing, it increases the burden of proof for such large price reduction. The associated price shock could have a chilling effect on the regulatory climate and affect investment decisions in all areas affected by regulation. It is therefore important considering the arguments about the effects of a UBA price *increase* and asking, how they would change for the *large decrease* for UBA that is likely to happen under the IPP approach compared to the status quo. Such an analysis could help pacify those currently opposed to a significant reduction in the UBA price and could help prevent legislative action that could be detrimental to competition, which would not be in the LTBEU. Having said that I hasten to add that I was unsurprised by the UBA price resulting from the benchmark analysis. I would have expected a ballpark figure of about NZ$10 per month, based on international data, certainly nothing in the range of the retail-minus price of NZ$21.46.

Benefits and limitations of using TSLRIC as the true UBA cost

24. TSLRIC has proven to be valuable in setting regulated wholesale service prices, particularly in markets under expansion. Conceptually, it is the cost standard on which, at least on average, prices are based that would obtain under effective competition, thereby limiting the incumbent's ability to extract monopoly profits. Prices set this way provide entrants with the necessary information in respect of bypass (buy-or-make) decisions and at the same time provide incumbents with correct signals regarding their investment decisions. They assure (if properly applied) entrants the opportunity to take advantage of the business prospects offered by growing retail markets on essentially an equal footing with the incumbent. Furthermore, using TSLRIC for several (all) regulated services improves consistency between their prices (fulfilling a relativity requirement).

25. The use of TSLRIC has certain limitation that have to be kept in mind when considering deviations from the TSLRIC cost standard. First and foremost, it is a long-run cost standard that can deviate from that applicable to real life decisions on expanding, contracting or building new facilities or on setting prices in a competitive context. An incumbent with a large portion of sunk costs will keep the network running even if TSLRIC are not fully covered. On the other hand he

[3] It should be noted that the UBA price had been lower than the UBA price that was 'frozen' as at Separation Day.

will invest in new capacity only if TSLRIC are fully covered, and that can include an allowance for the real option to wait that is extinguished by the investment.

26. A second limitation of TSLRIC in practice is that they are often measured as an average over the whole area of a country, while costs differ substantially by region, in particular by density. This means that the true costs in some (low-density) areas are below the average, while in other (high-density) areas they are above the true costs. This can have substantial effects on bypass investments and on pricing decisions.

27. It is worth regarding the further limitations of TSLRIC in the context of a technology at the end of its life cycle. From an economic perspective it is highly questionable to use TSLRIC for a technology that nobody invests in. What then is the value of a long-run approach for the functions of TSLRIC? How does one counter Chorus' argument that they have to repay their new investments in UBA within a much shorter time than the asset lives envisaged by the Danish and Swedish regulators in their cost models? This may be one of the potential problems of running the old copper technology alongside the new fiber technology. It may also be one of the problems of sticking with TSLRIC when in fact most of the assets used for UBA are not new and may even be fully depreciated.

28. However, the TSLRIC approach can be saved if the old technology disappears because there is a new technology that replaces the old one. In that case, the new technology may provide a modern equivalent asset (MEA) to the old access product and then TSLRIC may be applied using the MEA approach.[4] As far as I know, the Swedish regulator has used FTTH (in high-density areas) and mobile broadband (in low-density areas) as MEA for copper UCLL access but I do not know if this also extends to the UBA costing model. The Swedish regulator does not adjust the MEA for quality differences between copper and fiber access.[5] Thus, the current Swedish approach would give an upper bound for the true MEA (at least in high-density areas).

29. Generally, a MEA should be applied instead of the technology currently in use if (in the particular geographical area) no one would rationally invest in the old technology but rather only in the new technology. Sweden has already made that choice, and Switzerland is currently debating it. Both countries use a point-to-point FTTH technology. The current UFB plans for New Zealand would also suggest a full technology switch for most of the country, while in the least densely populated areas mobile broadband may be the correct MEA. Applying FTTH as the MEA for copper access, however, can involve substantial difficulties, the main one being that currently straightforward wholesale services for UCLL and bitstream access only appear to exist for point-to-point FTTH technologies. In contrast, UCLL for GPON networks appears to be not currently available. This means that for GPON currently only the total costs for UBA could be calculated but not the separate parts for UCLL and the incremental costs of adding UBA to UCLL.

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[4] Using the MEA approach usually solves the issue of declining usage of a technology at the end of its life cycle. Continuing to apply TSLRIC to the old technology could mean that costs go up, while they should actually go down as the old technology expires. Thus, in using UFB as the MEA the usage relevant for TSLRIC can be kept at the total usage of the fixed access network with reductions in usage only for those subscribers who "cut the cord".

[5] See Neumann and Vogelsang for a method for including performance differences in a MEA approach. Neumann, K.-H., and I. Vogelsang, "How to price the unbundled local loop in the transition from copper to fiber access networks?" *Telecommunications Policy*, Forthcoming.

30. Given the sunk nature of copper access networks the opportunity costs of the copper network are likely to be way below TSLRIC. Counter to Chorus' argument I am convinced that this also holds for the UBA portion.

Relativity and the ladder-of-investment approach

31. An issue to be addressed specifically in the IPP pricing review is the relativity of the prices of UBA and UCLL. This can be seen in the context of the so-called ladder-of-investment hypothesis. In my view, this hypothesis has limited application.[6] In particular, it does not apply

(a) To a technology that is on its way out so that the relevant investments are no longer warranted. In this case service competition should prevail that may justify lower wholesale access charges than stipulated by the ladder-of-investment approach.

(b) To (inter-modal) investments in a different technology than the one supported by the wholesale access technology. This holds, for example, for cable TV investments done by others than the wholesale access seekers.

(c) To the case where duplicating investments are undesirable from a social welfare perspective even if they may be privately profitable. This could happen if the increase in costs from duplication outweighs the potential consumer benefits from price reductions caused by increased infrastructure competition.

32. A strict application of the ladder-of-investment approach could be interpreted as requiring an increase of the wholesale UBA price relative to the UCLL price because that could induce access seekers to climb the ladder of investment by an additional rung by adding network, DSLAM and collocation equipment. However, that could run into trouble with argument (a) above against using the ladder-of-investment approach because investments in UBA bypass would be in an outgoing technology. The questions here are if the remaining time horizon for copper access is still long enough to justify such investments and if some of these investments could be reused for later UFB access. Because of the uncertainties involved in answering these questions it appears best neither to favor such investments nor to handicap them. That means it is best to set both the UCLL and the UBA wholesale prices using the same cost-based methodology so that those investment decisions by access seekers can be made in a consistent and unbiased way.

33. There is also the related issue (b) of investment in a different technology than the one supported by the current wholesale access. Whether in New Zealand the move from DSL to UFB could be interpreted as such a move falling under case (b) will depend on the extent to which access seekers can use their current assets for the new technology. If unbundling investments for current UBA bypass can be utilized for future unbundling in the UFB environment then the additional rung of the ladder would be worthwhile and a stretching of the UBA costs could potentially be justified. This, however, appears to be highly uncertain because of the GPON technology to be used by Chorus.

[6] Since my name is on the original paper proposing the ladder-of-investment approach, I am always expected to favor this approach. See Cave, M., and I. Vogelsang, "How Access Pricing and Entry Interact", *Telecommunications Policy* 27, 2003, pp. 717-727.

34. Last, there could be the concern (c) of duplicative investment, although that may not be relevant under the Act that clearly favors the LTBEU. If Telecom invests in UBA bypass such investments could be welcome under the LTBEU objective. However, the question arises why Chorus would risk this duplication by others by asking for such high UBA charges. Chorus would then lose a large part of its UBA revenues to such bypass (that would be enhanced by Telecom selling UBA to others). The only explanation appears to be that a high regulated UBA charge gives Chorus the freedom to price at that high price in geographic areas and at times it sees fit and lower the price if needed in response to competition (nevertheless subject to non-discrimination). Thus, Chorus could threaten price reductions in response to unwanted investments by others.

35. Like many hypotheses the ladder-of-investment approach can be adapted to new circumstances, to which it did not fit originally. However, the main original idea was to use regulation to move from service competition to more and more infrastructure-based competition with the ultimate aim of eliminating regulation, once entrants are at eye level with the incumbent. In my view, s 18 does not have this objective but rather promotes the subset of competition that is in the LTBEU. In particular, for UFB a long-term situation of (wholesale) market dominance and continued regulation is envisaged.

Effects on the promotion of competition for the long-term benefit of end-users

36. In the following we first consider the effect of a UBA price increase above (or decrease below) the true cost on unbundling competition and then on network investments by providers other than the subsidized UFB networks, which we treat separately below in the section covering innovation.

37. Unbundling competition is currently restricted to competitors other than Telecom, who is legally restricted to using UBA access until the end of 2014. The large reduction in UBA charges associated with the move from retail minus to cost-based UBA prices in this pricing review is likely (a) to halt the expansion of unbundling competition by current unbundlers into less densely populated areas and (b) nevertheless to lead to additional unbundling by Telecom, which may also extend into less densely populated areas than the other RSPs. The latter will depend on Telecom's ability to reuse the unbundling investments in the future UFB environment and on the unbundling capacities Telecom can purchase from other RSPs. From this price base (= true UBA cost) substantially below the current UBA price a small price increase in UBA will have little effect on unbundling investments other than by Telecom, who will invest more in unbundling. Telecom's unbundling costs will (like those of Chorus and the RSPs) vary by population density. For any given population density Telecom's unbundling costs will be close to but probably above the Chorus cost because Chorus still has a much larger "market" share for UBA services. This holds, in particular, because of cabinetization that severely limits unbundling. Nevertheless at a UBA price above true cost Telecom will unbundle in order to stay competitive against the RSPs. Telecom's unbundling could be complete in dense areas, severely threatening Chorus' position there. However, any long-run UBA price change will affect the marginal area in which Telecom will choose to unbundle. This, together with the limitation on unbundling in cabinetized areas will keep Telecom's ability in check to reduce the effective UBA price down to

the true UBA cost.[7] The current RSPs have done their unbundling at substantially higher prices and will not expand to unbundle further exchanges now, at lower prices (even if increased from the much lower base). They may add customers at currently unbundled exchanges, though. Turning to a price reduction below the true UBA cost this will only reduce Telecom's planned unbundling investments further. Because of sunk costs the current unbundlers will not disinvest and therefore will rather experience profit reductions (increases) from this UBA price reduction (increase) for their unbundled business but will at the same time benefit (suffer) for their UBA-based business. Thus, we can expect that most of the UBA price reduction will be passed on to final consumers, while part of a UBA price increase will be buffered by additional unbundling investment of Telecom.

38. It appears that the extent of copper unbundling for Telecom will very much depend on its ability to reuse the equipment with longer life for fiber unbundling from 2019 onwards. I understand that some access seekers today claim that they can unbundle for 3-4 NZ$ per month and thereby can recover their investments over a very short period. However, this only demonstrates the tight connection between UBA costs and network density. This short payback works in very dense areas but not in less dense urban or rural areas. If such a large amount of additional unbundling actually happens it could trigger partial stranding of Chorus' facilities in densely-populated areas and will mean that Chorus' UBA costs will become higher than the average costs under full coverage of the country.

39. The unbundling triggered by a higher UBA price is unlikely to lead to a lower end-user price than those that ruled before the increase in the UBA price. If unbundling is unprofitable at the lower UBA price then its costs will quite generally not be so low that it will lead to lower end-user prices than using UBA at the lower price. In order for end-user prices ex post to be lower than before the UBA price increase there would either have to be specific cost effects (sunk costs and larger scale) or lower downstream margins. What one can safely expect, though, is that any additional unbundling will reduce the price-increasing effect of a higher UBA price. Also, there can be other consumer benefits from additional service qualities and from the more robust infrastructure-based competition created by additional unbundling. Turning to a price reduction below the true UBA cost there will be more of a pass-through to final users due to the sunk costs of unbundling.

40. Similar arguments as for unbundlers hold for investors in alternative technologies (other than the subsidized UFB). Past investments here are largely sunk. New investments are handicapped by the subsidized UFB. As a consequence a reduction (increase) in the UBA price relative to the true UBA cost is unlikely to reduce (increase) investment in the footprint of alternative technologies. Because past investments are mostly sunk a reduction in UBA charges will generally not lead to disinvestment but rather intensify inter-modal competition, such that UBA price reductions will be passed on. In contrast, new investments will be impeded by Chorus' commitment to the UFB build-out and by the associated government subsidies. Nevertheless, UBA price increases will only partially be passed on to consumers, because higher prices will induce facilities-based competitors to acquire more subscribers within their footprint.

[7] There is an ex ante and an ex post issue here: Ex ante, Telecom would not invest in unbundling if the expected price were below true UBA cost. Ex post, once Telecom has invested, the price could under fierce competition go below true UBA cost because Telecom's unbundling costs are largely sunk.

41. Summing up, we expect that an increase (decrease) in the UBA price relative to the true UBA cost will lead to a price increase (decrease) for final consumers, but that this effect is dampened by additional (reduced) competition, in particular from unbundling. This dampening effect, however, will be stronger for UBA price increases than for price reductions.

Effects on the efficiencies in the sector

42. In case of a price increase there may be wasteful duplicate unbundling investment, which would be prevented by a price decrease. Such duplicate investment, however, is less wasteful to the extent that it helps improve service quality offered by RSPs. Nevertheless, it makes a UBA price reduction improve efficiency as compared to a price increase.[8]

Effects on the incentives to innovate that exist for, and the risks faced by investors in new telecommunications services that involve significant capital investment and that offer capabilities not available from established services

Incentives to innovate

43. Having discussed the UBA price effects on unbundling and investments by alternative network providers above in the section on competitive effects we here concentrate on UFB-related investments. There are two important aspects to be analyzed. First, UBA prices can affect UFB revenues and penetration via the resulting end-user prices or via the attractiveness of the UBA vs. the UFB wholesale markets. Second, there can be a direct effect of UBA prices on the profitability and the financing ability of Chorus.

44. The first of these issues is famously treated in Bourreau, Cambini and Dogan (2012),[9] who distinguish between three effects of wholesale pricing of the old technology on the deployment of the new technology by an integrated incumbent. The *wholesale revenue effect* reduces the incentives to invest in the new technology because such investment cannibalizes profits. This effect calls for low wholesale charges for the old technology in order to make the old technology less attractive than the new technology. This effect should be less relevant for Chorus because of the incumbent's commitment to invest in UFB. The wholesale revenue effect is only important to the extent that Chorus can renege on their investment commitment. However, as discussed below, a similar effect should be relevant for the RSPs' decisions to switch from DSL to UFB. The *replacement effect* induces alternative investors (the RSPs) to invest in the new technology. This calls for high wholesale charges as an umbrella for such investments. Again, this effect is less important for New Zealand, because such alternative investments are handicapped by the UFB subsidies. Any replacement effect would be very local. Last, the *business migration effect* captures the effect of wholesale charges on consumer prices and their willingness to switch to the new technology. In New Zealand the business migration effect appears to be the most important one.

45. The pace of migration from DSL (or other copper products) to UFB will certainly be influenced by both the prices of the UFB products and of the copper products. There have been few empirical

[8] Other potential efficiency effects besides the LTBEU are taken up below in the section on incentives to innovate and the risks associated with such innovations.

[9] Bourreau, M., Cambini, C., Dogan, P. (2012), "Access pricing, competition, and incentives to migrate from "old" to "new" technology", *International Journal of Industrial Organization* 30, pp. 713-723.

estimates of the price-quantity effects related to such a migration. The only one known to me is a migration study of 19 of 30 OECD countries for the years 2000-2008 (Shinohara, Akebatsu, and Tsuji, 2011).[10] Although this study concentrates on those countries with the highest FTTx penetration, only 8 of the countries had more than 10% FTTx penetration by 2010. It is therefore not surprising that the direct elasticity found by the authors for FTTx is very high (-6.394) and the cross elasticity for FTTx w.r.t. the DSL price is also comparatively high (+1.189).[11] As expected, because of the larger subscriber base of DSL and the higher FTTx price, these elasticities are both substantially higher than the corresponding direct elasticity for DSL (-0.951) and cross elasticity (+0.385). The results suggest that the DSL price may be lower than profit maximizing (although, because of sunkness the relevant marginal costs may be close to zero) and the FTTx price may be higher than profit maximizing. It also suggests that substantially more can be gained for FTTx migration by reducing the FTTx price than by increasing the DSL price. The main question, however, is to what extent these model results travel from the 2000-2008 OECD countries to 2016-2024 New Zealand. One main obvious difference is that during the period analyzed in the Shinohara et al. study DSL was starting at low penetration levels and continued to grow in most countries. In contrast, New Zealand in 2016 will have reached a level of saturation at which total broadband subscription demand may be almost totally inelastic w.r.t. price. That would mean that any gain of DSL would mean a similar loss of UFB and vice versa. Leaving aside for a moment the possibility that Chorus would lose UBA customers to unbundlers this would explain why Chorus has a strong interest in an increase of the UBA price. It would only lose customers to itself. The Shinohara et al. study does suggest a fairly robust sensitivity of migration w.r.t. the price difference between DSL and UFB, but the quantitative magnitude for New Zealand cannot be derived from the study.

46. Thus, while higher (lower) prices for copper-based services clearly could induce (prevent) end-users to switch to UFB services, it is hard to predict the extent to which that will occur. New telecommunications services are experience goods so that the speed of adoption depends on the experience of previous adopters. Price has played a role in the spread of other new technologies, such as mobile services and ordinary broadband. However, the price effect is only one of several, such as the QoS and the availability of complementary appliances and services. Thus, while a positive (negative) migration effect can be expected from an increased (decreased) UBA charge, the size of the effect is highly uncertain.

47. All this also has to be seen against the background of higher willingness to pay (WtP) for UFB wholesale access as compared to UBA wholesale access. This higher WtP is somewhat mitigated by higher downstream cost for UFB than for DSL. If, as suggested in a Chorus presentation, the WtP for UFB for 23% of consumers is at least 20NZ$ higher than for DSL this does not translate into a similar differential for the wholesale access seekers.[12] WIK has done some FTTH cost

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10 Shinohara, S., Akebatsu, Y., and M. Tsuji, "Analysis of broadband services diffusion in OECD 30 countries: Focusing on open access obligations", paper given at 8th ITS Asia-Pacific Regional Conference, Taiwan, June 26-28, 2011. Available at http://hdl.handle.net/10419/52312.

11 It should be noted that this cross-elasticity is significant only at the 10% level. In contrast, the other elasticities are significant at least at the 5% level.

12 Colmar Brunton report, *Chorus consumer segmentation research – Paving the Path to Delivering Ultra Fast Broadband*, 2012. The Commerce Commission also conducted its own demand side study on WtP for fibre services. The Commission found that only 4% of respondents were willing to pay more than NZ$20 per month and that most respondents were willing to pay between NZ$5-10. However, the study also revealed that retailers expect a WtP difference of NZ$19 and that the speed requirements for services are increasing

modeling (e.g., for ECTA), where the downstream costs of P2P FTTH were about 5 Euro per month higher than for copper access.[13] Using the above NZ$20 consumer WtP difference would then lead to about 12NZ$ difference in wholesale WtP. This seems to be about in line with the price differences between DSL and UFB that would result from the Commission's December 3, 2012, Draft Determination.

48. The effect of higher (lower) UBA charges on RSPs is a future lessening (an increase) of business opportunities relative to UFB wholesale. Here we can see first a quantitative effect from the consumer migration and second a margin effect from the different wholesale charges for UBA and UFB unbundling relative to the consumers' WtP for the copper and UFB products. Whether this is an additional effect to the one already described in the last paragraph depends on the competitiveness of the two end-user markets. To the extent that Telecom can make use of its scale economies it will continue to have some advantage in the copper markets. It is not clear that it can carry this advantage over to the UFB markets. This is a potential advantage of the switch to UFB for the other RSPs and that could make the downstream market for UFB potentially more competitive than for copper and may lead to a push into this market that could compensate part of the above price effects. It has, however, been argued in the CallPlus/Kordia submissions that "unbundling resulting from adding an increment to the regulated UBA price might lead the unbundlers concerned not to migrate their customers to the UFB as fast as they would have at a lower UBA price". The reasoning here is that for unbundlers with sunk investments the higher UBA price raises the price-cost margin for selling DSL to end users, while they would have to buy wholesale access to UFB at the same high price as before. This cannibalization effect is similar to the wholesale revenue effect discussed above. It would make unbundlers reluctant to migrate to UFB. Foreseeing that context Chorus could have incentives to actually reduce the UBA price below the regulated price if it wanted to enhance migration to UFB and to safeguard its wholesale revenues from UBA.

49. The effects on innovation of a price increase (decrease) is positive (negative) in the sense that all substitutes of UBA see their prices or expected penetration (at fixed prices) rise (fall). This holds for UFB in particular, but also extends to Chorus' commercially offered copper-based products, such as VDSL. However, all these effects on innovation are dampened by the competitive interaction that works for the static benefits as described above. Given the subsidies provided for UFB investments (including the high UBA price for Chorus until end of 2014) and the contracts the UFB investors entered into, the positive (negative) effects on innovation will be substantially smaller than otherwise.[14] At the end, any migration effect has to be balanced against the negative (positive) effect such higher (lower) UBA charges have on consumers of

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rapidly so that higher WtP differences can be expected in the next few years. See Commerce Commission New Zealand, "High speed broadband services demand side study", 9 February 2012. Available at http://www.comcom.govt.nz/assets/Telecommunications/Studies/UFB-Demand-Side/High-speed-broadband-issues-paper-3-Content-and-willingness-to-pay-9-February-2012.nrl.pdf.

[13] Higher downstream costs for FTTH include customer premises equipment costs and higher costs for Ethernet ports. Entrants also incur additional optical distribution frame costs. I do not know if such cost are likely to occur in the New Zealand context or not.

[14] Complements will often but not always experience the opposite effect of substitutes. This holds, for example, for software and appliances that are purchased in association with network services. Thus, higher UBA prices can dampen such complementary services, while lower prices can increase them. However, to the extent that higher (lower) UBA prices help (handicap) UFB penetration that will help (handicap) services complementary to UFB.

UBA-based services. In particular, the negative (positive) effects of higher (lower) UBA charges on the LTBEU of UBA-based services accrue for a long time even for those users that ultimately switch to UFB and forever for those users not willing or able to switch.

Effects on the risks faced by investors affecting their ability to finance UFB investments

50. The effects of a price increase (decrease) on the financing ability for UFB investment differs substantially between Chorus and the LFC areas. For Chorus in its own UFB investment areas there is a direct effect from its UBA revenues plus an indirect effect via the penetration of UFB affected by the UBA price, while for the LFCs in their areas there is only the latter indirect effect. In addition, the LFCs face Chorus as a formidable competitor who may undercut the regulated UBA price cap, because on account of sunkness Chorus' forward-looking costs will be much below the TSLRIC. Chorus could here follow a limit-pricing strategy, trading off an accelerated (inevitable) loss in market share against higher markups on UBA cost.

51. The indirect effects are an immediate consequence of the above analysis of the penetration effects. A large fraction of the UFB investment in penetrating geographic areas is sunk, but there are additional investments varying with subscribership that arise from connecting individual customers and neighborhoods. Also, under GPON some of the investments in geographic areas vary with take-up. Thus, although not all the revenue effects from changed penetration translate into profit changes, a large part does, and this affects the ability to finance UFB build-out via the cost of capital of the investors.

52. The direct effect is similarly apparent. An increase in UBA charges, to the extent that it increases net UBA revenues, potentially lowers Chorus' cost of capital by increasing the value of its equity. This was apparent from Chorus' share price reduction following the announcement of the Commission's December 3, 2012, Draft Determination.

53. For both the direct and the indirect effects the question is if they justify deviations from the true UBA costs. In particular, should the UBA users be asked to subsidize the UFB deployment by having to pay a price above the true costs? Or, alternatively, should the UFB investors suffer because the UBA price is subsidized?

54. One could argue that there is no effect of the current pricing review on the financing of UFB, because the price reduction from the retail minus approach to the cost-based IPP had to be expected. This is true within limits, but Chorus' share price decline immediately following the Commission's December 3, 2012, Draft Determination seems to indicate clearly that there was a surprise for analysts and shareholders, resulting in an increase in Chorus' cost of capital. Under the conventional economists' view about markets there must have been genuinely new information. Such an unexpected price shock based on a regulatory decision could have a chilling effect for any investments affected by regulatory decisions. From an economic perspective this could justify a surcharge on the true cost. I cannot judge if such a surcharge would be covered by the Commission's pricing discretion under s 18.

55. The conventional view is that there are large spillover effects from fiber adoption. The main question is if those are already fully reflected in the subsidies granted to the UFB investors. Since New Zealand is a small country, its spillover effects on software developments or the like may be smaller than in large countries.

56. A decision not to consider such spillover effects therefore has good justifications. Such spillover effects are hard to assess. As a result the decision about incorporating spillover effects should be left largely to politicians and the legislature. This has in fact happened in New Zealand, because the UFB build-out is deliberately subsidized. One can argue that the subsidized build-out reflects a political decision about the value of the spillover effects. Spillover effects from UFB investments come in two forms. Most direct are spillovers in the form of network effects on new applications that directly benefit the UFB subscribers. Such effects are not taken into consideration in the subscription decisions of potential new subscribers, leading to too few subscribers. In contrast, more indirect spillovers affect the economic growth of a country via improvements in productivity and the like. While one can argue that the latter indirect effects should be the concern of the central government, a case can be made for the former direct effects to be the concern of the Commerce Commission both with respect to the LTBEU and efficiencies gained for the telecommunications sector. As a result innovation incentives and risks faced by investors could potentially justify a UBA price above the true cost. In contrast, a UBA price below true cost has to be seen as conflicting with the goals of s 18.

Summary of the consequences of (small) price increases or decreases of the UBA price relative to the true UBA cost on the s 18 goal fulfillment

57. The evidence so far suggests that deviations from true costs pose tradeoffs. There is no reason for a surcharge on top of the true UBA cost based on ladder-of-investment arguments. An increase in the UBA price may incentivize innovations and buffer risks of the investments associated with such innovations. In addition, network effects of additional UFB subscriptions may justify higher UBA prices than true UBA costs. However, to the extent that an increase in the UBA price is dampened by competitive effects it will also be less helpful in triggering innovation. One cannot have it both, no adverse effects on the LTBEU of copper-based products and positive effects on innovation and penetration of UFB. Conversely, because of a smaller dampening effect a UBA price reduction below the true UBA cost will have stronger negative effects on UFB penetration and investment risk. Overall, at this point of the analysis an increase of the UBA price compared to true cost appears to be justified, while a decrease may be outright harmful. However, so far we have not looked systematically at the effects of cost averaging and have only considered small price changes.[15]

Consequences of geographic averaging for the relationship between TSLRIC and true cost

58. A difficult issue concerns the effects of geographic averaging of TSLRIC on the achievement of the s 18 objectives. Since geographic averaging is required by law, the question is not if it is good or bad. Nevertheless, it is important to look at the potential effects of averaging in light of incentives that are influenced by price levels.

(a) While both, the UBA costs and the UCLL costs appear to depend on network density it seems clear that the UCLL costs are more sensitive to density than the (incremental) UBA costs. Since only Chorus is (or has been) investing in the UCLL product, it will under cost averaging have less of an investment incentive in rural areas and more of an investment incentive in urban areas than in a de-averaged state. That may be counter-productive given that copper loops will only be replaced by UFB in urban areas.

[15] In this context, price changes up to 10% can be considered "small".

(b) Turning to UBA, this is already geographically averaged (for the incremental UBA part) because the end-user prices it was based upon were geographically uniform. Maintaining this is in line with geographic averaging for UCLL prices. Such averaging nevertheless means that generally the UBA price is below TSLRIC in rural areas, where it may keep cooper loops competitive against mobile broadband. Since the averaging means comparatively higher prices in urban areas and lower prices in rural areas, copper unbundling will be incentivized in urban areas and prevented in rural areas.

59. Chorus faces different types of future competition in three types of geographic areas. (a) It will provide both wholesale services for copper access and for UFB access in those areas, where it is committed to invest in UFB. (b) It further will provide only copper services in UFB areas to be served by LFCs. (c) Last, it will provide only copper services in areas, where no UFB investments are planned.

60. One can argue that in the first type of areas Chorus is (at the wholesale level) only competing with itself and therefore does not face any competition. This provides a very strong justification for continued UCLL and UBA regulation. Many of the arguments above refer to this type of competition (or the lack thereof). In type (a) areas Chorus will try to maximize joint profits from UFB deployment and from copper. Given its UFB investment commitment and the limited remaining life span for copper Chorus will best treat both the copper and UFB networks as sunk investments and will therefore concentrate on the migration incentives. Chorus will therefore prefer a high UBA price that will facilitate migration to UFB (with its potentially high revenues and lower variable costs). On the other hand the areas of type (a) include the most densely populated parts of the country. This means that an averaged TSLRIC-based UBA price is likely to be well above true UBA cost. The main disturbance will therefore come from Telecom's potential investments in unbundling, something that Chorus may be able to preempt or postpone through threats of UBA price *reductions*.[16]

61. Since Chorus' UBA costs are largely sunk, a loss of wholesale revenues to unbundlers can mean a substantial profit reduction.[17] The empirical case for the proposition that the market will fix any "too high" UBA charge by forcing Chorus to make the correct adjustment depends on a complicated interaction of variables that are hard to assess at this time and especially for someone not in this market like Chorus or Telecom. However, Chorus' ability and incentives to reduce the price below the regulated price are, in my view, not part of this pricing review, which is about finding the right regulated price. If that price turns out not to be binding and if this happens over substantial geographic areas and time spans then deregulation may be warranted. A lower regulated UBA price will increase competition from copper against UFB in those areas. In contrast, under a higher UBA price Chorus would only have the option to price competitively in those areas but it is not guaranteed that Chorus will make use of this option.

62. In LFC areas Chorus' main interest will be in maximizing profits from copper alone against a more competitive new UFB technology. Again, there is the threat of Telecom's investments in unbundling but because of a lack of migration incentives Chorus may have less of an incentive for high UBA charges if lower charges could postpone UFB migration. This is a typical limit pricing issue. Although the areas of type (b) include some high-density cities, most of them will

[16] However, Chorus and Telecom could not strike a special deal to stop Telecom unbundling. This would not be possible due to the Chorus non-discrimination undertakings. If Chorus struck a deal with Telecom, then the same terms and conditions would also have to be made available to other access seekers.

[17] It would still be assured the wholesale revenues from UCLL.

probably have average population density for the country and therefore the true UBA costs will be close to the geographically averaged TSLRIC determined in the IPP. These costs will be relevant for Telecom's decision to unbundle but not for Chorus' decision to stay in there. Unbundling from Telecom will therefore be less of a threat than in type (a) areas.

63. In areas, where there is no investment in UFB, Chorus will mainly compete against wireless (and partially against cable TV) services and may be able to hold its ground for longer than in areas of type (b). Thus, it may have a stronger incentive to keep the UBA price high. This will be helped by the fact that because of low population density and high costs there will be little threat from Telecom's unbundling. Even at higher UBA prices Telecom will likely continue to serve these areas at geographically averaged end-user prices, while other RSPs may choose not to serve them. At the same time, depending on whether or not Chorus will continue with copper investment in these areas its true costs may be high or low (respectively sunk).

64. In sum, while Chorus generally has an interest in high UBA charges as a price ceiling, it will want to have the option selectively to lower the price to meet competition. Regulated UBA charges at the geographically averaged TSLRIC will be significantly above the weighted average of true costs in areas where Chorus invests in UFB, will be close to the weighted average of true cost in LFC areas and will be below average true cost in rural areas without UFB. As a result, geographic averaging of TSLRIC costs will already achieve some compromise between setting prices above true costs in order to incentivize innovations and reduce investment risks and acting in the LTBEU in areas that will not be served by UFB.

What are the consequences of larger price changes?

65. Are there asymmetric effects of price increase vs. price decrease? The conventional wisdom on regulated prices is that a price increase spurs investment/innovation for closely substitute services, while a price reduction reduces such investment/innovation incentives. This, however, only holds for a limited range of prices in the neighborhood of true costs, because it only takes the supply side into consideration. It is well known that firms would like to increase their supply as a response to a price increase. However, firms with market power (and the sum of all firms in a market) face demand constraints that bind more and more, as the price is increased. Thus, while at a price below true cost a firm may invest/innovate nothing, it will expand investment/innovation rapidly at prices above costs. Because of uncertainty about costs and market conditions there is a range for which this holds but this range is limited, and then the demand constraint sets in.

66. This argumentation applies directly to Chorus' investments in copper-based UBA. While Chorus is obliged to continue offering copper UBA services where needed, such investments, are likely to be low anyhow in the future. Disinvestments are unlikely because of the sunk nature of the investments done already. However, Chorus' profits would be very negatively affected by very low UBA charges and positively affected by very high UBA charges, thereby affecting the financing ability for UFB investments.

67. The above argumentation indirectly also applies to Chorus' and the other LFCs' ability to migrate customers to UFB. At very low UBA charges the resulting low end-user prices for copper-based services will prevent migration of subscribers to UFB, while at very high UBA charges the

resulting high end-user prices for copper-based services will make migration to UFB attractive. Thus, low prices will hinder and high prices will help UFB investments.

68. However, as above for small price changes adaptation will come into play. A substantial price increase relative to the true UBA cost would bring the UBA price in the neighborhood of the current UBA price. While unbundling of further exchanges by current unbundlers may be limited, there is ample room for further lines to be unbundled. Also Telecom can be expected to unbundle even into rural areas. This total additional unbundling is likely to buffer end-users from a large part of the UBA price increase, although this will at the same time lead to duplication and therefore productive inefficiencies.

69. To the extent that the high UBA price will trigger additional unbundling this will raise the cannibalization issue mentioned above. At the high price level for copper-based services caused by the high UBA charge the unbundling RSPs will be very reluctant to switch to UFB, because their unbundling costs are sunk whereas they would have to pay for UBA if they switch to UFB. The questions then are (a) if there are enough RSPs willing to switch because of little or no unbundling investments or (b) if the wholesale market for copper-based UBA becomes sufficiently competitive to negate the high copper UBA charge. While these may be countervailing effects, the resulting equilibrium will likely involve lower DSL prices that reduce the migration effect.

70. Furthermore, while adaptation to high UBA charges in densely-populated areas may be close to perfect (above a certain UBA price level) it will be much less so in rural areas.

71. In contrast, a very low copper UBA charge will lead to low prices for copper-based services and that will frustrate migration from copper-based services to UFB. Thus, overall there will be less adaptation possibilities for too low UBA price than for too high UBA price (which itself may not be binding).

72. Summing up, while for a large UBA price increase the violation of the s 18 objectives may be substantial, particularly in rural areas, it will be much larger for a large price decrease, because that jeopardizes Chorus' and to some extent the LFCs' ability to make UFB investments.

IV. The expected value and likely errors in measuring UBA cost

Is the median of the benchmark countries an unbiased estimate of the UBA costs?

73. Is, as the Commission's Draft Determination stipulates, the UBA price at the median of the Danish and Swedish UBA costs the correct estimate of the true TSLRIC of UBA in New Zealand? What is the best estimate for the expected value and what is the likely probability distribution of cost estimates? In the following we take the working assumption that the Danish benchmark price is below the Swedish benchmark price.[18]

[18] I have been advised by the Commerce Commission to take the assumption that the Danish price point is below the Swedish price point for the purposes of this advice.

74. Without valuing any of the arguments brought forward there it would appear from the submissions and cross-submissions in this pricing review that the expected true TSLRIC of UBA for New Zealand lie above the median. If in a contentious pricing review one side claims costs (substantially) higher than the median and the other side does not claim it to be below the median it most probably is somewhat above the median. Otherwise the other side would have found arguments that it is below the median. In particular, Chorus (based on CEG) tries to prove that UBA costs in New Zealand would be substantially larger than in Denmark and Sweden on account of the lower customer density in New Zealand. For this purpose, it presents econometric estimates based on technical assumptions about the service delivery of UBA. Low-density areas here are characterized by long backhaul lines and under-utilized DSLAMs. This means that the network is not well adapted to the low densities. Cross-submissions by, e.g., Telecom, Network Strategies and Analysis Mason argue that networks adapt to lower densities by adjusting equipment capacity or trading off backhaul line lengths against size of DSLAMs and data throughput. Therefore the cost increase due to lower density would not materialize in the form claimed by Chorus/CEG. However, the adjustments only cushion the density effect, not eliminate it. Thus, the density argument is likely to be true, although not to the extent claimed by Chorus. Having said this, the DSL density in Sweden is actually slightly lower that in New Zealand, whereas it is substantially higher in Denmark. This would establish a fairly strong case against using the median as the UBA price.

75. The size of adjustments necessary for lower line densities is highly uncertain. Chorus presents a very one-sided analysis. Besides the rebuttals found in some of the other cross-submissions two arguments were left out of Chorus analysis. The first is that there probably is a larger fraction of users in New Zealand that cannot be reached by DSL than in Denmark or Sweden. Counting out those users as irrelevant for UBA the New Zealand density should not be so much lower than that of the other two countries. The second is that – as shown in CEG/Chorus' graphs – the derivative of cost with respect to density in the denser areas is quite small, while it is quite large in the less dense areas. However, a lot of the differences in density between New Zealand and Denmark/Sweden seem to occur in the urban areas, where most of the people live. Thus, the cost difference between New Zealand and the two other countries should actually be quite small, although probably not zero.

76. Telecom's assertion about similarity of UBA costs across countries because of the high dependence of UBA costs on international equipment markets may be intuitive. However, there were rebukes, one saying that internationally traded equipment requires exchange rates rather than PPP for comparisons, the other (Chorus) saying that Telecom's argument does not consider density and other factors. A clean (econometric) analysis for adjusting the benchmark results to reflect the New Zealand circumstances would be quite complex (including taking care of the adjustments in equipment and network architecture for different densities) and would, in my view, totally defeat the purpose of the IPP. It would, in my view, be out of proportion and would catapult the IPP both in terms of resource use and time requirement to the same level as the FPP. We therefore do not want to go further into the nitty-gritty of explaining or adjusting the benchmark figures for Denmark and Sweden.[19] Nevertheless, an adjustment via the weight

[19] There is, however, an issue only addressed superficially in this pricing review (and, as far as I see, only at one point in the submissions and cross-submissions), and that is the size of the WACC to be used for the costing exercise. I mention this for two reasons.

given to each of the two countries may be warranted. For, example, Sweden may actually be closer in geographical properties to New Zealand than Denmark is.

77. In conclusion, if the benchmarking shows Denmark with lower UBA cost than Sweden, but Sweden has lower UBA density than Denmark, then the cost differences between the two countries may well be explained by the differences in density. Because New Zealand's density is very close to that of Sweden the Swedish observation is probably much closer to the true expected value for New Zealand than the Danish observation. Consequently, a value at the 75% or even the 100% mark between the benchmark costs of Denmark and Sweden appears to be justified.

Error analysis

78. An error analysis usually tries to assess the expected net costs in terms of goal fulfillment of type I and type II errors. Under risk neutrality a decision maker would want to minimize the sum of these expected costs. Thus, the questions asked for any level of measured UBA costs are, (a) what is the probability that the true cost is higher than the measured value and what are the (valued) consequences of accepting this measured result as the regulated price, and (b) what is the probability that the true cost is lower than the measured value and what, in this case, are the (valued) consequences of accepting this measured result as the regulated price?

79. Moving the expected value of the true benchmark away from the median towards the Swedish costs raises at least two complications.

(a) The first complication is that the probability distribution of the true costs does no longer seem to fit nicely into the interval spanned by the Danish costs as a lower bound and the Swedish costs as an upper bound. From a cognitive point of view the two benchmark observations neatly define a distribution, although almost certainly the true distribution extends well beyond those points and is probably asymmetric, because it is bounded from below but not from above.[20] In my view, the shift of the expected value upward suggests a somewhat wider distribution. If one had restricted the

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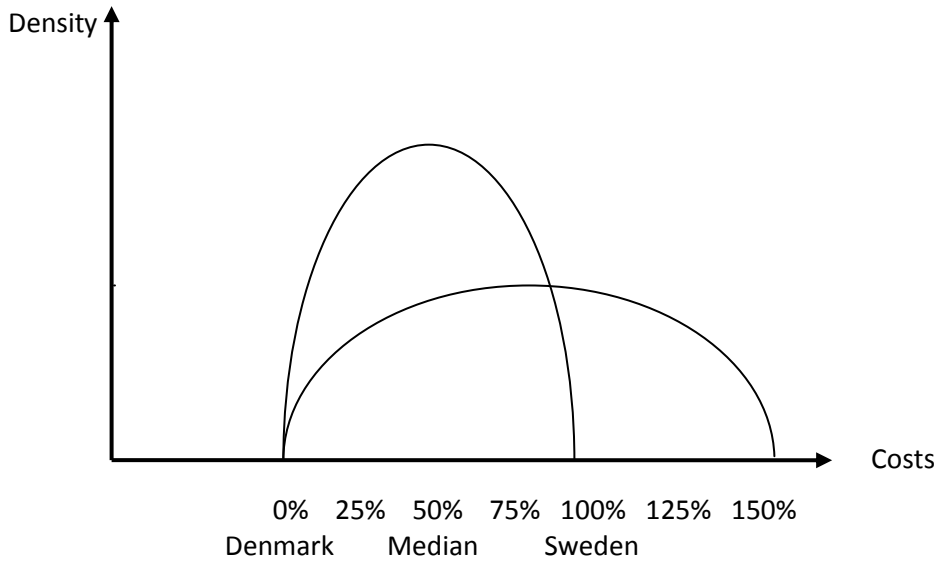
(a) The first reason is that one can argue that the WACC is a very major input price that is not clearly linked to the level of currency exchange rates and to the purchasing power parities used to convert the costs found in the benchmark countries into New Zealand dollars. Interest rates are known to affect inflation and the *change* in exchange rates but I am not aware of obvious links to the price and exchange rate *levels*. One could therefore make some argument for using the WACC as another adjustment parameter. This would, however, be difficult in any exact way, because the percentage of the TCLRIC that is due to the WACC is unknown. For UCLL in Italy WIK (in a 2011 report for ECTA) states that an increase in the WACC by 17% (e.g., from 8% to 9.36%) leads to a cost increase of 10-11%. For UBA this percentage may be lower but definitely not insignificant. Given that the influence of the WACC on total costs is quite complicated and, due to different asset lives, is not the same for UBA as for UCLL I would not suggest a numerical adjustment to the benchmarks to be made. Rather, a comparison of the WACC used in the benchmark countries with an appropriate New Zealand WACC should provide guidance on whether the result of each benchmark country might be biased upward or downward for the New Zealand application.

(b) The second reason for addressing the WACC is that many countries (e.g., in the EU) use an increase in the WACC as an instrument for incentivizing investment by the incumbent in new infrastructure. This question, however, is already addressed above by looking at the effects on investment of a price increase or decrease relative to the true costs.

[20] Applied to the median of NZ$8.93 found in the December 3 Draft Determination a cost of zero has zero probability, while a cost of 2x$8.93 = NZ$17.86 has some positive probability.

distribution before to points between the Danish and the Swedish costs and where now to move the expected value from the median to the 75% mark then I would extend the distribution at least to the 150% mark, so that the Danish costs would still be given some probability. Figure 1 gives an example of such two distributions.

Figure 1: Two range distributions of cost estimation errors



(b) The second complication arises from the fact that, as shown in Section III above, the cost of an error (in terms of LTBEU lost) is likely to increase more than proportionally in the size of the error one is making. This holds particularly strongly for the downward error. This property limits the deviation from the expected value one should optimally make because of the error asymmetry. For example, if, as a result of the error asymmetry one increases the price by 25%-points above the expected value then one reduces the size of the error that the resulting price will be below costs. However, the size of the expected error that the price will be above costs will be increased by this move. Thus, the (marginal) cost of the error with the larger costs is decreased while the size of the error with the smaller costs is increased. As a result, the (marginal) costs of the two errors come closer and can cross each other. The optimum is reached where the two (marginal) error costs of too high or too low a UBA price are equal. Depending on the slopes of the cost curves this can happen quite quickly. It suggests that the mark-up on costs resulting from asymmetric error costs should be quite limited, such as to 25%-points.

80. We can say quantitatively little about the error distribution of the UBA cost observations relevant for New Zealand. However, the benchmark data in general and the small difference between the cost for Denmark and Sweden in particular suggest that it is fairly tight. Since it is bounded below but not above, it is most likely asymmetric around some peak value. Because of the asymmetry the peak value does not coincide with and is smaller than the expected value of the distribution. On both sides the densities will monotonically decline, as one moves away from the peak value (single peaking).

81. Having analyzed the costs of errors and the likely error distribution we can now bring these two items together. The method consists in principle of multiplying the costs of errors with their probabilities and then adding them over all probabilities. This should be done for each price point chosen. For example, we may start with the expected value of the error distribution, which we suggested above to be at the 75% point between the costs of Denmark and Sweden. Then we characterize a simple error distribution consisting, for example of the extended range described above in Figure 1, using 25% intervals. Then we choose probabilities associated with each interval at the nodes. These have to sum to one. They should be asymmetric. Thus, the 0-25% interval should have a lower probability than the 125%-150% interval. However, also because of the asymmetry the 50%-75% interval should have a higher probability than the 75%-100% interval. Next, we have to assign numerical values for missing the s 18 objectives for deviations from the true costs. The thought experiment here is: If we choose the 75% mark as the UBA price, what is the error cost if the true UBA cost is at the 0% mark? In this case we have a large overestimate of the true cost, i.e., we charge a price that is substantially too high, and that has a certain cost. In contrast, if the true cost were at the 50% mark the price would only be a little too high with much lesser consequence. In the last step all the error costs are multiplied by their probabilities and then summed over all probabilities. This whole process is then repeated for each plausible price value and the one with the smallest summed error costs is chosen. In the appendix we provide some very simple numerical examples unrelated to the current pricing exercise. They show in particular, that in spite of asymmetric valuations and error distributions one need not deviate much from the expected value of the error distribution and that there can be a range of optimal values. In any case, care should be taken in estimating the expected value.

82. While neither we nor the Commission can actually estimate the error distribution or the error costs, the conceptual exercise helps in providing the direction of the optimal price from the expected value of the distribution. It is clearly above the expected value. Furthermore, it helps limit the amount, by which the optimal value will exceed the expected value, which is most probably in the 25%-50% range of the difference between the two benchmark values of Denmark and Sweden.

V. Conclusions

83. The objectives of s 18 and s 19 are fulfilled by a price certainly not below but possibly above true costs. In addition, the error analysis indicates that the price should be above expected costs. Furthermore, the expected value of Chorus' UBA costs appears to be above the median between the UBA cost of Denmark and Sweden. Combining these factors justifies a UBA price at the measured UBA cost of Sweden. Such a price at the 100% mark would still be compatible with a requirement to stay within the benchmarking range. In my view, it could even exceed this value. Since objective measures are not available, these statements are based on subjective probability assessments.

Appendix: Numerical Example of error cost minimization

84. A very simple numerical example can bring out the main points. We assume two cases, one with the median (= 50% mark) as the expected value of costs and one with an expected value at the

76.5% mark. Probabilities are assigned only to the values 0%, 25%, 50%, 75% and 100% and error costs are measured against these percentages. We assume two scenarios of error costs as in Table 1. Scenario 1 has exponentially increasing error costs, while the error costs increase linearly in scenario 2.

Table 1: Error costs

Deviation: Negative for a too low price and positive for a too high price	Cost of deviation: Scenario 1	Cost of deviation: Scenario 2
-100	80	40
-75	40	30
-50	20	20
-25	10	10
0	0	0
25	5	5
50	10	10
75	20	15
100	40	20

85. Table 2 shows the case, where there are asymmetric error costs, but the expected UBA costs are at the median and the distribution is symmetric with all probabilities equal to 0.2. The error costs in each cell are derived by multiplying the error derived from the percentage distance between the cell and the chosen price with the probability associated with the cell. The total error cost for each scenario is derived by summing the error costs vertically. Since scenario 1 has an exponential increase in error costs, we see that a move from the median to the 75% mark does not improve the result in spite of asymmetric error costs. However, in scenario 2 with linearly increasing error costs the move to the 75% mark lowers total expected error costs.

Table 2: Assessment for expected costs at the median

Cost observation	Probabilities of true costs	Error costs: Scenario 1: price at median	Error costs: Scenario 1: Price at 75%	Error costs: Scenario 2: price at median	Error costs: Scenario 2: Price at 75%
0%	0.2	2.0	4.0	2.0	3.0
25%	0.2	1.0	2.0	1.0	2.0
50%	0.2	0	1.0	0	1.0
75%	0.2	2.0	0	2.0	0
100%	0.2	4.0	2.0	4.0	2.0

Totals	1.0	9.0	9.0	9.0	8.0

86. Table 3 shows the case, where there are asymmetric error costs and the expected costs are at the 76.5% mark with an asymmetric distribution of probabilities bounded between 0% and 100%. In contrast to the result in Table 2 the change in expected value moves the optimum under scenario 1 to the 75% mark, which again equals the 100% mark. However, under scenario 2 with linearly increasing error costs the optimum further moves to the 100% mark.

Table 3: Assessment for expected costs at the 76.5% mark

Cost obser-vation	Probabilities of true costs	Error costs: Scenarios 1 and 2: price at median	Error costs: Scenario 1: Price at 75%	Error costs: Scenario 1: price at 100%	Error costs: Scenario 2: Price at 75%	Error costs: Scenario 2: Price at 100%
0%	0.05	0.5	1.0	2.0	0.75	1.0
25%	0.05	0.25	0.5	1.0	0.5	0.75
50%	0.1	0	0.5	1.0	0.5	1.0
75%	0.4	4.0	0	2.0	0	2.0
100%	0.4	8.0	4.0	0	4.0	0
Totals	1.0	12.75	6.0	6.0	5.75	4.75